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Guidance and Control Software Project Data

Volume 4: Configuration Management and Quality Assurance Documents

Edited by
Kelly J. Hayhurst
Langley Research Center, Hampton, Virginia

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National Aeronautics and
Space Administration

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Abstract

The Guidance and Control Software (GCS) project was the last in a series of software reliability studies conducted at Langley Research Center between 1977 and 1994. The technical results of the GCS project were recorded after the experiment was completed. Some of the support documentation produced as part of the experiment, however, is serving an unexpected role far beyond its original project context. Some of the software used as part of the GCS project was developed to conform to the RTCA/DO-178B software standard, "Software Considerations in Airborne Systems and Equipment Certification," used in the civil aviation industry. That standard requires extensive documentation throughout the software development life cycle, including plans, software requirements, design and source code, verification cases and results, and configuration management and quality control data. The project documentation that includes this information is open for public scrutiny without the legal or safety implications associated with comparable data from an avionics manufacturer. This public availability has afforded an opportunity to use the GCS project documents for DO-178B training. This report provides a brief overview of the GCS project, describes the 4-volume set of documents and the role they are playing in training, and includes configuration management and quality assurance documents from the GCS project.

1 Introduction and Background on Software Error Studies

As the pervasiveness of computer systems has increased, so has the desire and obligation to establish the reliability of these systems. Reliability estimation and prediction are standard activities in many engineering projects. For the software aspects of computer systems, however, reliability estimation and prediction have been topics of dispute, especially for safety-critical systems. A primary challenge is how to accurately model the failure behavior of software such that numerical estimates of reliability have sufficient credibility for systems where the probability of failure needs to be quite small, such as in commercial avionics systems (ref. 1). A second challenge is how to gather sufficient data to make such estimates. Software reliability models are not used in the civil aviation industry, for example, because "currently available methods do not provide results in which confidence can be placed to the level required for this purpose." (ref. 2)

In an effort to develop methods to credibly assess the reliability of software for safety-critical avionics applications, Langley Research Center initiated a Software Error Studies program in 1977 (ref. 3). A major focus of those studies was on generating significant quantities of software failure data through controlled experimentation to better understand software failure processes. The intent of the Software Error Studies program was to incrementally increase complexity and realism in a series of experiments so that the final study would have statistically valid results, representative of actual software development processes.

The Software Error Studies program started with initial investigations by the Aerospace Corporation to define software reliability measures and data collection requirements (ref. 4-6). Next, Boeing Computer Services (BCS) and the Research Triangle Institute (RTI) conducted several simple software experiments with aerospace applications including missile tracking, launch interception, spline function interpolation, Earth satellite calculation, and pitch axis control (refs. 7-11). The experiment design used in these studies generally involved a number of programmers (denoted n) who independently generated computer code from a given specification of the problem to produce n versions of a program. In these experiments, no particular software development standards or life-cycle models were followed. Because the problems were relatively small and simple, the versions were compared to a known error-free version of the program to obtain information on software errors.

Although the initial experiments were small and simplistic compared with real-world avionics development, they yielded some interesting results that have influenced software reliability modeling. The BCS and RTI studies showed widely varying error rates for faults. This finding refuted a common assumption in early software reliability growth models that faults produced errors at equal rates. These studies also provided evidence of fault interaction where one fault could mask potentially erroneous behavior from another fault, or where two or more faults together cause errors when alone they would not. (ref. 12) Additional investigations with n -version programs (ref. 13) found that points in the input space that cause an error can cluster and form “error crystals”. Extrapolating this finding to aerospace applications, where input signals tend to be continuous in nature, the error crystals may manifest themselves as clusters of successive faults that could have unintended consequences. (ref. 14)

The last project in the Software Error Studies program was the Guidance and Control Software (GCS) project. It built on the previous experiments in two ways: (1) by requiring that the software specimens for the experiment be developed in compliance with current software development standards, and (2) by increasing the complexity of the application problem (ref. 15). At the time of the GCS project, the RTCA/DO-178B guidelines, “Software Considerations in Airborne Systems and Equipment Certification,” (ref. 2) were the primary standard sanctioned by the Federal Aviation Administration (FAA) for developing software to be approved for use in commercial aircraft equipment (ref. 16). The DO-178B document describes objectives and design considerations to be used for the development of software as well as verification, configuration management, and quality assurance activities to be performed throughout the development process. The DO-178B guidelines were selected as the software development standard to be used for the GCS specimens.

The software application selected for the GCS project, as the title indicates, is a guidance and control function for controlling the terminal descent trajectory of a planetary lander vehicle. This terminal descent trajectory is the same fundamental trajectory referred to as the “seven minutes of terror” in the entry, descent, and landing phase of a planetary mission, such as the recent Phoenix Mars Lander (ref. 17). For the GCS project, the software requirements were reverse engineered from a simulation program used to study the probability of success of the original NASA Viking Lander mission to Mars in the 1970s (ref. 18). It is important to emphasize that the software requirements documented for the GCS project, while realistic, are not the actual software requirements used for NASA’s Viking Lander or any other planetary landers.

For the GCS experiment, two¹ teams of software engineers were each tasked to independently design, code, and verify a GCS program, following the software development guidance in DO-178B, as closely as possible. In addition to those teams, another GCS version was produced,

¹ The original plan for the GCS project called for three independent teams. Due to funding constraints, only two teams were able to complete the project.

without the constraint of compliance with DO-178B, to aid development and verification of the requirements and simulation environment. Once all versions were complete, data on residual errors was supposed to be collected by running all the versions simultaneously in a simulation environment, and using any discrepancies among the results of the versions as possible indications of errors.

Results of the operational simulations and data collection are described in (ref. 15). The purpose of this report is not to repeat those results, but to disseminate some of the project documentation that has an unanticipated utility beyond its original project context. The project documentation of interest is the documentation developed by the teams required to comply with the DO-178B standard. That standard requires extensive records of all of the software development life cycle activities. For the GCS project, those records included 18 documents consisting of life cycle plans, development products including requirements and source code, verification cases and results, and configuration management and quality control data. Comparable data from a commercial avionics system would not be available for public review because of proprietary and other legal considerations. The GCS project documentation is not subject to those considerations because it is not data from an actual operational, or even prototype, system. But, the data has sufficient realism to provide a window into the types of activities and data involved in the production of DO-178 compliant software, which makes the GCS documentation desirable from a training perspective.

The remainder of this report provides a brief overview of aspects of the GCS project relevant to using the documentation for training. This information includes a description of the GCS application, a synopsis of the software development processes used to follow the DO-178B guidance, and the data that was generated as a result. Because the complete set of compliance documents is large, the documents have been divided into four sets (planning, development, verification, and configuration management and quality assurance process documents) contained in separate volumes of this report. Volume 4 includes in Appendices A-F all of the GCS documents generated as part of the software quality assurance and configuration management activities, as well as an accomplishment summary.

2 Guidance and Control Software Application

The requirements for the GCS application focus on two primary functions: (1) to provide guidance and engine control of the lander vehicle during its terminal phase of descent onto the planet's surface, and (2) to communicate sensory information to an orbiting platform about the vehicle and its descent. Figure 1 shows a sketch of the lander vehicle, taken from (ref. 18), noting the location of the terminal descent propulsion systems.

The guidance package for the lander vehicle contains sensors that obtain information about the vehicle state and environment, a guidance and control computer, and actuators providing the thrust necessary for maintaining a safe descent. The vehicle has three accelerometers (one for each body axis), one Doppler radar with four beams, one altimeter radar, two temperature sensors, three strapped-down gyroscopes, three opposed pairs of roll engines, three axial thrust engines, one parachute release actuator, and a touch down sensor. The vehicle has a hexagonal, box-like shape; three legs and a surface sensing rod protrude from its undersurface.

In general, the requirements for the planetary lander only concern the final descent to the surface. Figure 2 shows a sketch of the phases of the terminal descent trajectory.

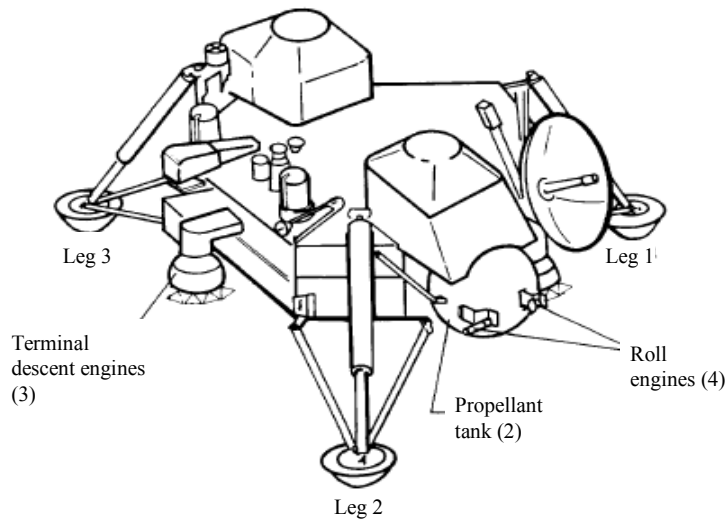


Figure 1. Lander with Terminal Descent Propulsion Systems

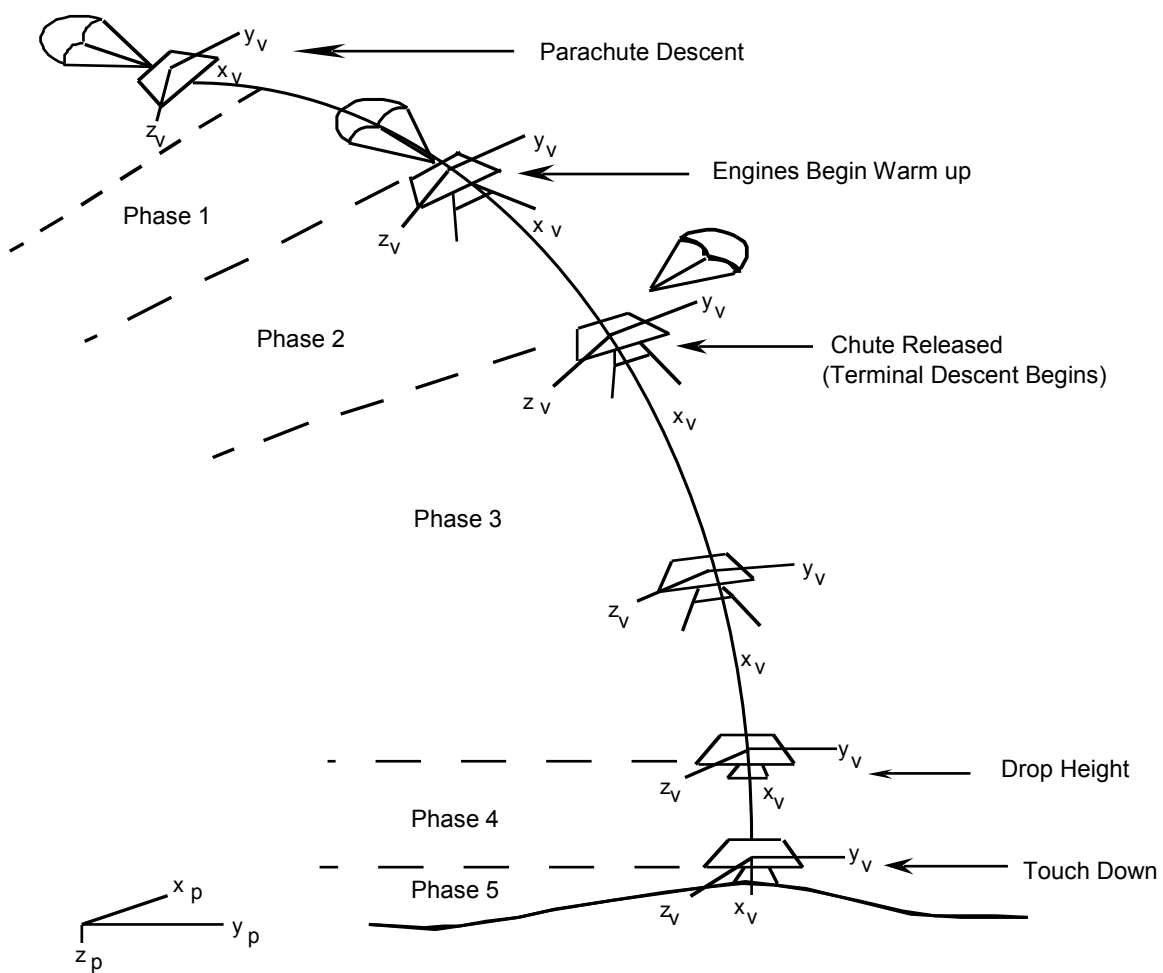


Figure 2. A Typical Terminal Descent Trajectory

After the lander has dropped from orbit, the software controls the engines of the vehicle to the surface of a planet. The initialization of the GCS starts the sensing of vehicle altitude. When a predefined engine ignition altitude is sensed by the altimeter radar, the GCS begins guidance and control of the lander. The axial and roll engines are ignited; while the axial engines are warming up, the parachute remains connected to the vehicle. During this engine warm-up phase, the aerodynamics of the parachute dictate the vehicle's trajectory. Vehicle attitude is maintained by firing the engines in a throttled-down condition. Once the main engines become hot, the parachute is released and the GCS performs an attitude correction maneuver and then follows a controlled acceleration descent until a predetermined velocity-altitude contour is crossed. The GCS then attempts to maintain the descent of the lander along this predetermined velocity-altitude contour. The lander descends along this contour until a predefined engine shut off altitude is reached or touchdown is sensed. After all engines are shut off, the lander free-falls to the surface.

The software requirements for this guidance and control application are contained in a document called the *Guidance and Control Development Specification* (in Volume 2). As mentioned earlier, the initial requirements for this application were reverse engineered from a simulation program used to study the probability of success of the original NASA Viking Lander mission to Mars. Prior to use in the experiment, the requirements were revised to make them suitable for use in an *n*-version software experiment. Each of the GCS programs for the experiment were developed from the same requirements document.

3 Software Life Cycle Processes and Documentation

Having some of the project teams adhere to the DO-178B guidelines as they created a software version for the experiment was a significant element of the GCS project, requiring the development and tracking of numerous software engineering artifacts not normally associated with a software engineering experiment. The purpose of DO-178B is to provide guidelines for the production of software such that the completed implementation performs its intended function with a level of confidence in safety satisfactory for airworthiness. Along with the production of software is the generation of an extensive set of documents recording the production activities.

DO-178B defines software development activities and objectives for the development life cycle of the software, and the evidence that is needed to show compliance. The life-cycle processes are divided into planning, development, and integral processes. The planning process defines and coordinates the software development processes and the integral processes. The software development processes involve identification of software requirements, software design and coding, and integration; that is, the development processes directly result in the software product. Finally, the integral processes function throughout the software development processes to ensure integrity of the software products. The integral processes include software verification, configuration management, and quality assurance processes. Section 11 of DO-178B describes data that should be produced as evidence of performing all of the life cycle process activities (see Table 1).

For the GCS project, some of this data was common for all of the teams, and other data was intended to be specific to each team. For example, each team worked with the same plans, standards, and requirements. Then, each individual team was responsible for independently developing their own design, code, and corresponding verification data. To distinguish the versions, each team was assigned a planetary name: Mercury, Venus, and Pluto².

² At the time the GCS experiment was conducted, Pluto had not yet been relegated to non-planet status.

Table 1. Life Cycle Data

Planning Process Documents	Development Process Documents	Integral Process Documents
<ul style="list-style-type: none"> • Plan for Software Aspects of Certification • Software Development Plan • Software Verification Plan • Software Configuration Management Plan • Software Quality Assurance Plan • Software Requirements Standards • Software Design Standards • Software Code Standards 	<ul style="list-style-type: none"> • Software Requirements Data • Design Description • Source Code • Executable Object Code 	<ul style="list-style-type: none"> • Software Verification Cases and Procedures • Software Verification Results • Software Life Cycle Environment Configuration Index • Software Configuration Index • Problem Reports • Software Configuration Management Records • Software Quality Assurance Records • Software Accomplishment Summary

The DO-178B data associated with the development of the Pluto version of the GCS was selected for publication. Most of the GCS documents correspond directly with the life cycle data listed in Table 1. All together, the documentation includes over 1000 pages. So, for dissemination purposes, the Pluto data was divided into the following 4 subsets:

Volume 1: Planning Documents

- *Plan for Software Aspects of Certification of the Guidance and Control Software Project*
- *Software Configuration Management Plan for the Guidance and Control Software Project*
- *Software Quality Assurance Plan for the Guidance and Control Software Project*
- *Software Verification Plan for the Guidance and Control Software Project*
- *Software Development Standards for the Guidance and Control Software Project*

Volume 2: Development Documents

- *Guidance and Control Software Development Specification*
- *Design Description for the Pluto Implementation of the Guidance and Control Software*
- *Source Code for the Pluto Implementation of the Guidance and Control Software*

Volume 3: Verification Documents

- *Software Verification Cases and Procedures for the Guidance and Control Software Project*
- *Software Verification Results for the Pluto Implementation of GCS*
- *Review Records for the Pluto Implementation of the Guidance and Control Software*
- *Test Results Logs for the Pluto Implementation of the Guidance and Control Software*

Volume 4: Other Integral Processes Documents

- *Software Accomplishment Summary for the Guidance and Control Software Project*
- *Software Configuration Index for the Guidance and Control Software Project*
- *Problem Reports for the Pluto Implementation of the Guidance and Control Software*
- *Support Documentation Change Reports for the Guidance and Control Software Project*
- *Configuration Management Records for the Guidance and Control Software Project*
- *Software Quality Assurance Records for the Guidance and Control Software Project*

Appendices A thru F in this volume contain all of the original configuration management and quality assurance documents, except for planning, for the GCS Project. The *Software Accomplishment Summary for the Guidance and Control Software Project*, in Appendix A, provides a summary of how the project complied with the *Plan for Software Aspects of Certification*. Appendix B contains the *Software Configuration Index for the Guidance and Control Software Project* that lists all of the project's data items under configuration control and also identifies the configuration of the software life cycle environment. Records of configuration management and quality assurance are provided in Appendix C (*Configuration Management Records for the Guidance and Control Software Project*) and Appendix D (*Software Quality Assurance Records for the Guidance and Control Software Project*). Finally, Appendix E contains all of the problem reports for the development artifacts (requirements, design, and source code); and Appendix F contains all of the change reports for the project's support documentation.

The content of the documents in the appendices has not been altered from the original versions produced during the project.

4 Role in Training

At the time of the GCS project, there was no publicly available information, such as templates, or examples, or training courses, to help a novice developer generate the type of evidence that a certifying authority would expect to see to demonstrate compliance with DO-178B. As mentioned earlier, compliance data from a real avionics system is not typically available for public review because of various legal and safety considerations. For example, an avionics manufacturer would likely consider the design and implementation of a system to be proprietary. Those considerations do not apply to the data from the GCS project, because neither the requirements nor the software versions represent an actual system with safety, liability, or other considerations.

In addition to the availability of data, the GCS requirements and DO-178B compliance data are sufficiently realistic to serve as an example of a DO-178B project: one that is small enough in scale to be studied in a training course. The GCS documentation provides a window into the activities and data produced throughout the development life cycle to comply with DO-178B. Because the Federal Aviation Administration (FAA) was aware of the GCS project, they recognized the potential value of the documentation for training. The FAA has designed software training to include a case study portion that addresses avionics software issues that arise from the application of the DO-178B guidelines. The case study gives students the opportunity to use auditing techniques to identify flaws in lifecycle data. Because the GCS data was produced by novices, there are plenty of flaws to find.

5 Summary

From 1977-1994, NASA Langley Research Center conducted a Software Error Studies program that generated data that provided insights into the software failure process and into conducting software engineering experiments as well. The GCS project was the final experiment in that program. A unique feature of the GCS project was the requirement for some of the software specimens used in the experiment to conform to the RTCA/DO-178B software standard, "Software Considerations in Airborne Systems and Equipment Certification," used in the civil aviation industry. The project documentation produced to meet that requirement has had the unanticipated benefit of serving as case study material in software certification training long after the conclusion of the original experiment. Volume 4 of this report contains all of the configuration management and quality assurance documents from the GCS project. Other volumes of this report contain the rest of the GCS compliance data including planning, development, and verification.

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Appendix A: Appendix A: Software Accomplishment Summary for the Guidance and Control Software Project

Author: Kelly J. Hayhurst, NASA Langley Research Center

This document was produced as part of Guidance and Control Software (GCS) Project conducted at NASA Langley Research Center. Although some of the requirements for the Guidance and Control Software application were derived from the NASA Viking Mission to Mars, this document does not contain data from an actual NASA mission.

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A.1 Introduction

The Guidance and Control Software (GCS) project is a research effort to investigate the faults that occur in the development and operation of software, especially software applications that conform to the Requirements and Technical Concepts for Aviation RTCA/DO-178B guidelines, "Software Considerations in Airborne Systems and Equipment Certification." To this extent, this project involved the production of two separate implementations of the GCS for the purpose of (1) collecting data on the faults that occur during the software development process, (2) collecting data on faults that occur in operational guidance and control software, and (3) making observations on the effectiveness of a development process that complies with the DO-178B guidelines.

The GCS project was started originally in 1985 at the Research Triangle Institute (RTI) (ref. A.1) with the development of the specification document for the guidance and control software application. The development of each of the two implementations described in this document started from a common specification of the requirements for the GCS (referred to as the GCS specification) and proceeded independently through the development of the design and code. Each GCS implementation was designed to run in conjunction with a software simulator that provides input to the implementation based on an expected usage distribution in the operational environment, provides response modeling for the guidance and control application, and receives data from the implementation. The GCS simulator is designed to allow an experimenter to run one or more implementations in a multitasking environment and collect data on the comparison of the results from multiple implementations. Certain constraints were incorporated in the GCS specification and project standards (especially standards regarding communication protocol) due to the nature of the GCS project.

As stated in section 11.20 of DO-178B, the *Software Accomplishment Summary* is the primary data item used to show the certification authority compliance with the project's *Plan for Software Aspects of Certification*. To this extent, this document contains an overview of the results of the GCS project, including:

- * an overview of the guidance and control application,
- * a statement of certification considerations,
- * a description of the characteristics of the final software products and the life cycle used to generate that product,
- * identification of the software configuration,
- * change history for the software products,
- * software status, and
- * compliance statement.

In general, this document presents an overview of activities involved in developing the two GCS implementations, especially noting any deviations from the project plans delineated in *the Plan for Software Aspects of Certification*. Summaries of the life cycle processes and data are presented along with the identification of the final software products. The following section gives a general overview of the GCS project.

A.2 Overview of the Software Application

According to DO-178B, the software requirements process uses the system requirements and system architecture to develop the high-level requirements for the desired software (ref. A.2). For the GCS project, however, there is no real system to be developed for use in a commercial aircraft system nor documentation of real system requirements. The GCS implementations will be executed only in a simulated operational environment to collect data for the research effort.

As stated above, the GCS project started with the definition of software requirements for a specific component of a guidance and control system. The definition of the software requirements focused on two primary needs for the software: (a) to provide guidance and engine control of a lander vehicle during its terminal phase of descent onto the planet's surface and (b) to communicate sensory information to an orbiting platform about the vehicle and its descent.

In general, the GCS is designed to control a planetary lander during its final descent to the planet's surface. After the lander has dropped from orbit, the software will control the engines of the vehicle to the surface of a planet. The initialization of the GCS starts the sensing of vehicle altitude while the vehicle is in free-fall with its parachute attached. The aerodynamics of the parachute dictate the trajectory followed by the vehicle. When a predefined engine ignition altitude is sensed by the altimeter radar, the GCS begins guidance and control of the lander by igniting the axial and roll engines. While the axial engines are warming up, the parachute remains connected to the vehicle. Vehicle attitude is maintained by firing the engines in a throttled-down condition. Once the main engines become hot, the parachute is released and the GCS performs an attitude correction maneuver and then follows a controlled acceleration descent until a predetermined velocity-altitude contour is crossed. The GCS then attempts to maintain the descent of the lander along this predetermined velocity-altitude contour. The lander descends along this contour until a predefined engine shut off altitude is reached or touchdown is sensed. After all engines are shut off, the lander free-falls to the surface. Figure A.1 shows the terminal descent phase of the lander.

The lander vehicle to be controlled includes a guidance package containing sensors which obtain information about the vehicle state, a guidance and control computer, and actuators providing the thrust necessary for maintaining a safe descent. The vehicle has three accelerometers (one for each body axis), one Doppler radar with four beams, one altimeter radar, two temperature sensors, three strapped-down gyroscopes, three opposed pairs of roll engines, three axial thrust engines, one parachute release actuator, and a touch down sensor. The vehicle has a hexagonal, box-like shape with three legs as shown in Figure A.2 and a surface sensing rod protruding from its undersurface.

Figure A.1. A Typical Terminal Descent Trajectory

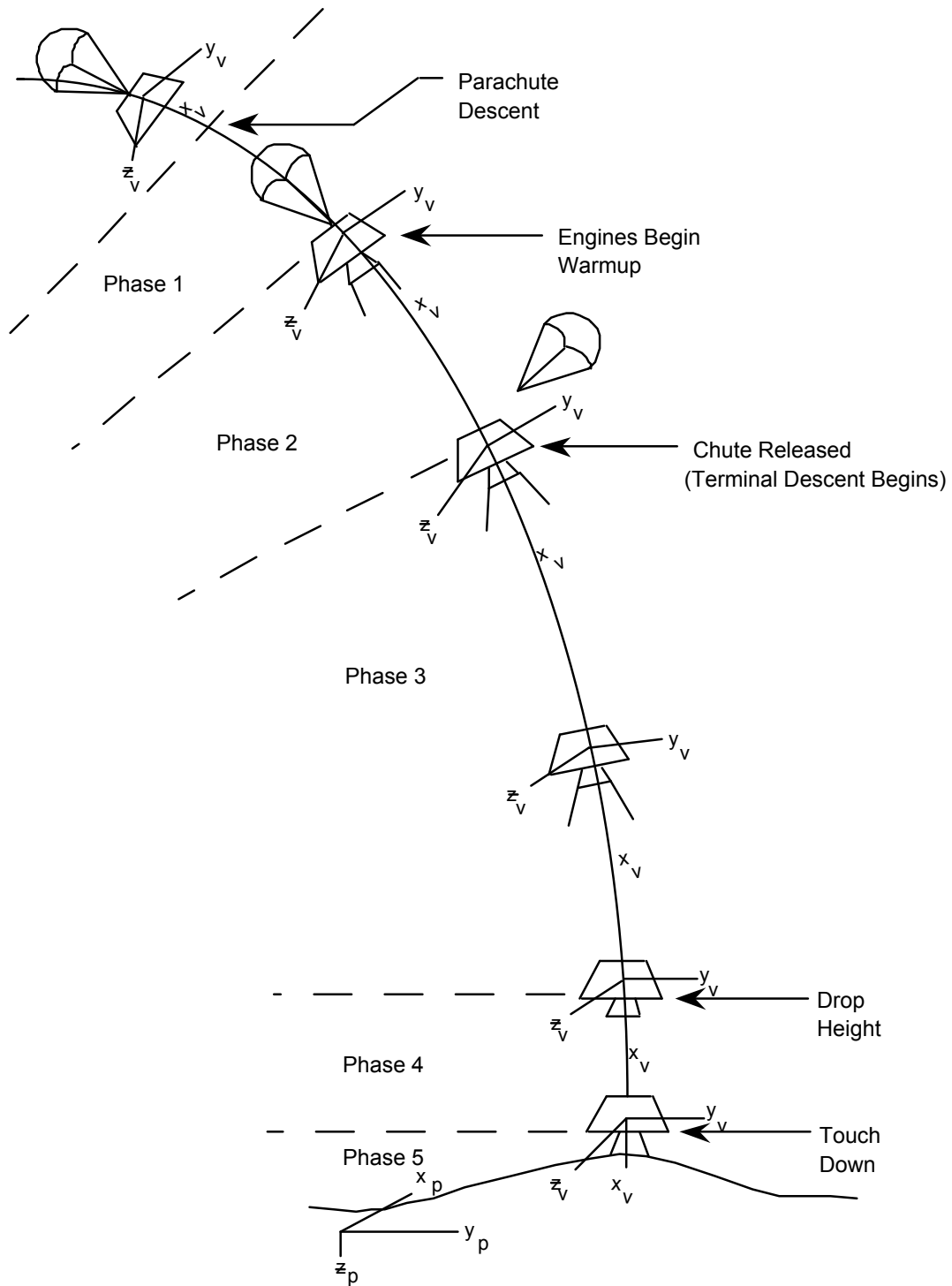
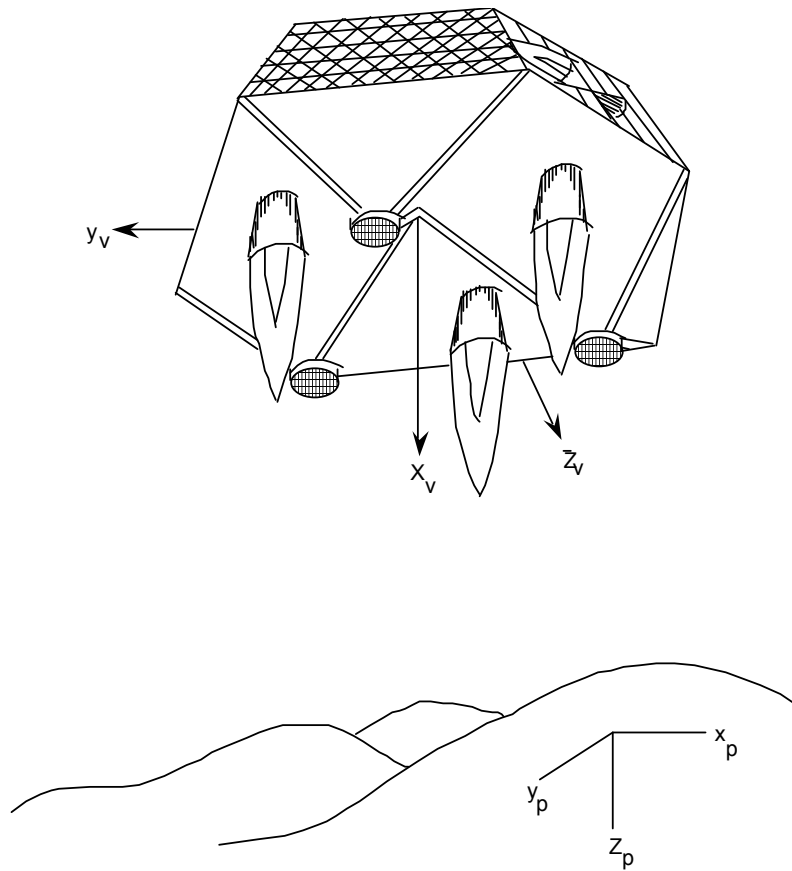


Figure A.2. Lander Vehicle



The software functions described above, as implemented in both GCS implementations, are the same as those described in the *Plan for Software Aspects of Certification*. The development of the two GCS implementations started with the release of version 2.2 of the GCS specification. During the course of the development effort described in the *Plan for Software Aspects of Certification*, there were thirty-seven modifications made to the GCS specification. Each of the modifications were accomplished through the Support Documentation Change Reporting (SDCR) procedures described in the *Configuration Management Plan*. Table A.1 gives a summary of each of the SDCRs for the GCS specification.

Table A.1. Changes to the GCS Specification

SDCR #	Date Approved	Description of Change	Module Affected	Related Change Reports
2.2-1	12/30/92	Clarify initialization of PE INTEGRAL, YE INTEGRAL and TE INTEGRAL	AECLP	
2.2-2	12/30/92	Clarify initialization of THETA	RECLP	
2.2-3	12/30/92	Clarify rounding of AE_CMD	AECLP	
2.2-4	2/8/93	Remove unnecessary text in Table 5.10	GP	
2.2-5	2/24/93	Add FRAME_COUNTER to list of input variables	ARSP	
2.2-6	3/10/93	Correct the data type of elements in the data dictionary	Data Dictionary	
2.2-7	3/10/93	Correct references to scalar and array variables	AECLP	
2.2-8	3/10/93	Correct the listing of variables as control law parameters	GP	
2.2-9	5/20/93	Add the definition of the term "data store"	Introduction	
2.2-10	5/27/93	Add new structured analysis charts and corresponding explanation	Level 0, Level 1 Specifications	
2.2-11	6/2/93	Add new structured analysis charts at Level 2 and corresponding changes	Level 2 Specification	
2.2-12	6/2/93	Change all references to new structured analysis charts (many labeling/numbering changes)	FOREWORD, Table of Contents, Lists of Figures and Tables, Introduction, Level 3 Specification	
2.2-13	6/2/93	Change title to reflect numbering of new charts and correct list of inputs	AECLP	
2.2-14	6/2/93	Change title to reflect numbering of new charts and correct list of inputs	GSP	
2.2-15	6/2/93	Change title to reflect numbering of new charts and correct list of inputs	RECLP	
2.2-16	6/2/93	Change title to reflect numbering of new charts and correct list of inputs	TDLRSP	
2.2-17	6/2/93	Change title to reflect numbering of new charts and correct list of inputs	TSP	
2.2-18	6/3/93	Change title to reflect numbering of new charts	ARSP, ASP, CRCP, TDSP	
2.2-19	6/3/93	Add reference to Teamwork documentation	Bibliography	
2.2-20	6/3/93	Change title to reflect new charts, delete unnecessary text	GP	
2.2-21	6/4/93	Change title to reflect new charts and correct list of inputs	CP	
2.2-22	6/4/93	Update description of structured analysis charts	Appendix A	
2.2-23	6/4/93	Miscellaneous corrections to data element descriptions	Data Dictionary	
2.2-24	6/7/93	Miscellaneous corrections to the data store descriptions	Data Dictionary	

Table A.1 (cont.). Changes to the GCS Specification

SDCR #	Date Approved	Description of Change	Module Affected	Related Change Reports
2.2-25	6/7/93	Miscellaneous corrections to the descriptions of the control variables, data conditions, and initialization data	Data Dictionary	
2.2-26	6/7/93	Clarify requirements for error handling when checking for upper and lower bound exceeded	Introduction	
2.2-27	1/13/94	Clarify Runge-Kutte Method for the simultaneous equations	Appendix C - Numerical Integration Instructions	
2.2-28	2/15/94	Clarify requirements for error handling when checking for upper and lower bounds exceeded	Introduction	
2.2-29	3/15/94	Minor clarifications (defined acronyms, added table heading, etc.)	All ** This created version 2.3 **	
2.3-1	5/13/94	Minor clarifications and revisions	Title Page and Introduction	
2.3-2	5/19/94	Change scheduling of the functional units and termination condition	Introduction, ARSP, TDLRSP, CP	Mercury PR# 14
2.3-3	6/9/94	Minor corrections and clarifications	Introduction, AECLP, ARSP, TDLRSP, CP	
2.3-4	8/24/94	Add statement for precision of floating point calculations, change form of standard deviation equation, correct data element descriptions	Introduction, ASP, Data Dictionary	Requirements-based Test Cases SDCR #4, 5, 6, 7
2.3-5	9/23/94	Correct Figure 1.1, correct input tables for ARSP, ASP, GP, TDSP, correct several data store location descriptions,	Introduction, ARSP, ASP, GP, GSP, RECLP, TDLRSP, TDSP, Data Dictionary	Mercury PR #25
2.3-6	12/21/94	Up date Preface, Bibliography, and clarify calculation of the checksum	Table of Contents, List of Tables, CP, Preface, Bibliography	Requirements-based Test Cases SDCR #8, 11
2.3-7	3/15/94	Clarify conditions for calculating mean and standard deviation, correct Table 5.9 and 5.10 to avoid square root of negative value	ASP, GP	Mercury PR# 30 Requirements-based Test Cases SDCR #24, 25, 26
2.3-8		Format entire spec using Teamwork		

The following section concerns the certification aspects regarding this guidance and control application.

A.3 Certification Considerations

The two primary functions of the GCS are: (1) to provide guidance and engine control of the lander vehicle during its terminal phase of descent onto the planet's surface and (2) to communicate sensory information to an orbiting platform about the vehicle and its descent. Although there is not a system safety assessment for the GCS project, it was assumed that the loss of either of these functions could cause or contribute to a catastrophic failure condition for the

vehicle. Consequently, the guidance and control application as defined in the GCS specification was considered to be Level A software, requiring the highest level of effort to show compliance with the certification requirements. Since the GCS is assumed to be Level A, (as opposed to a lower level requiring less effort to show compliance), no justification for this rating is provided. This is consistent with the statement of certification considerations given in the *Plan for Software Aspects of Certification*.

A.4 Software Characteristics

As stated previously, two separate implementations of the GCS, referred to as Mercury and Pluto, were developed for this project. The size of the executable object code for each implementation is given in Table A.2. Because each implementation was designed only to run in conjunction with a software simulator that is instrumented to collect data to support the research (as opposed to having resource restrictions due to being part of a larger system), there were no special timing or memory requirements specified for the software. Further, it is difficult to differentiate the execution time of the implementation from the simulator running in a VAX/VMS environment. Consequently, the timing and memory data given in Table A.2 is the average time and maximum memory used over a number of trajectories. The average execution time was measured by taking the total time to run 100 trajectories and dividing by 100; and, the maximum working set size was measured by observing the largest working set used while running the 100 trajectories.

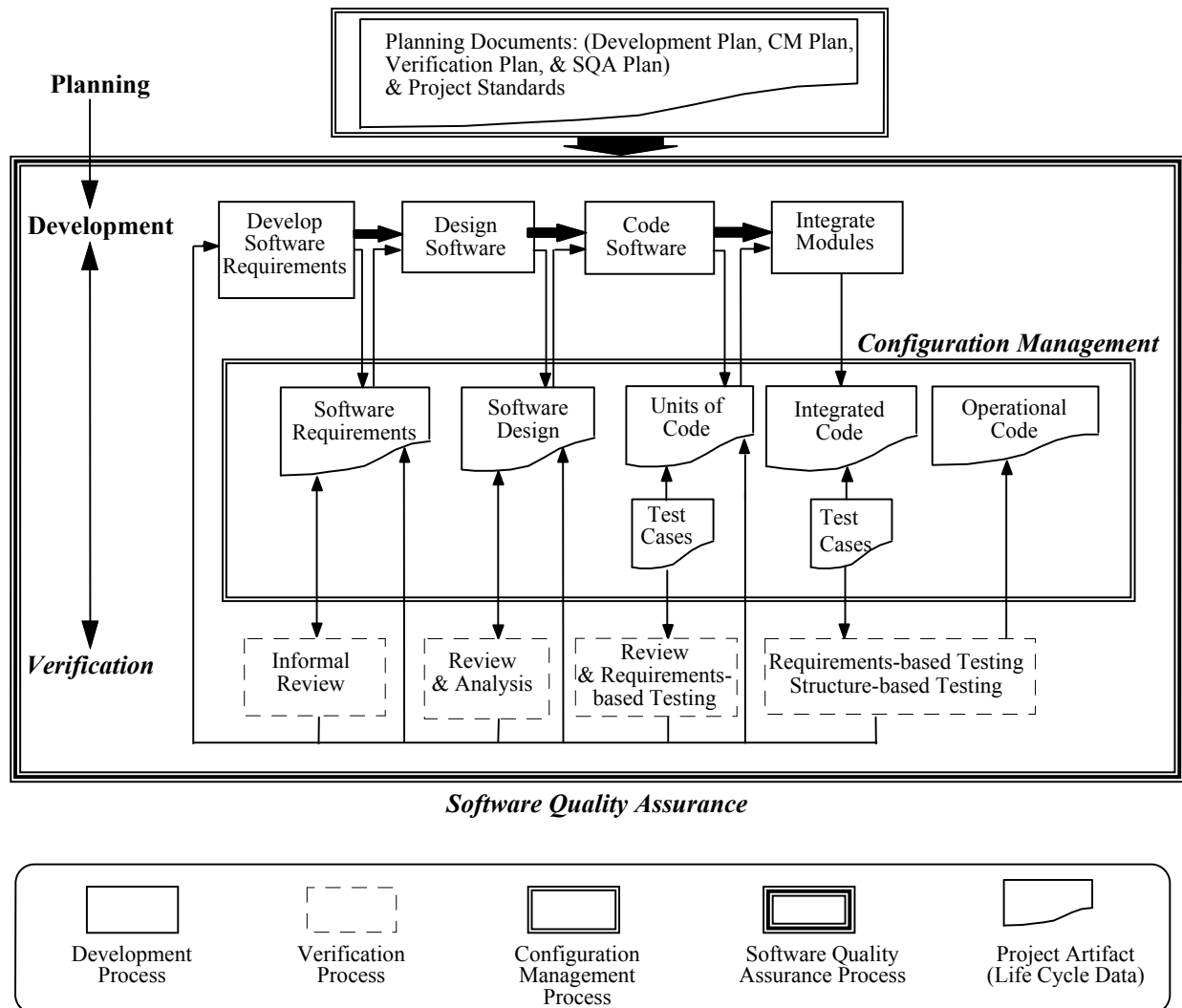
Table A.2. Software Characteristics

Software Characteristic	Mercury	Pluto
Executable Object Code Size	32768 bytes	24768 bytes
Average Execution Time per Trajectory	3.15 minutes	1.04 minutes
Maximum Working Set size per Trajectory	205312 bytes	198144 bytes

A.5 Software Life Cycle Processes

At a high level, the software life cycle processes for the GCS project consist of: the software planning process, the software development processes, and the integral processes. These processes, as described in the *Plan for Software Aspects of Certification* are given in Figure A.3.

Figure A.3. Flow of Life Cycle Activities for the GCS Project



The life cycle processes described in the *Plan for Software Aspects of Certification* and shown in Figure A.3 were accomplished in accordance with the plan with the exceptions. As previously stated, the requirements development process started with the revision of the GCS specification. The modification of the GCS specification was a significant effort and many changes were made following the release of version 2.2. Similarly, there was a significant effort involved in the modification of the RTI generated designs to comply with the revised GCS specification. Due to the difficulties in working with previously generated designs and the number of problems identified in the first design reviews, two complete design reviews were held for each GCS implementation (a preliminary and final design review). In retrospect, the project would have progressed more quickly if the programmers were allowed to start their designs from scratch (as opposed to modifying an existing design). The coding and integration processes proceeded as planned.

There were also a number of personnel changes during the course of the GCS project. Most notably, there were changes to both the programmer and verification analyst roles. Table A.3 lists all the individuals involved in the various project roles for the Mercury and Pluto implementations.

Table A.3. GCS Project Participants and Their Roles

Project Role	Individuals Involved
Project Lead	Kelly Hayhurst
Software Quality Assurance	Kelly Hayhurst, George Finelli, Carlos Liceaga
Configuration Manager	Laura Smith
Mercury Programmer	Ming Lin, Andy Boney
Mercury Verification Analyst	Debbie Taylor
Pluto Programmer	Paul Carter, Rob Angellatta, Philip Morris
Pluto Verification Analyst	Rob Angellatta, Patrick Quach

A.5.1 Life Cycle Data

The life cycle data specified in the *Plan for Software Aspects of Certification* were also produced. Table A.4 gives the list of that life cycle data. Each of the bulleted items in Table A.4 represents distinct documents that will be delivered to the certification authority at the conclusion of the project. These documents will be available in paper form or can be made available in electronic form as needed.

A.5.2 Relationship of Project Data

As given in Table A.4, the planning documents document were used to set the course for the development and integral process activities. The *Software Development Standards* document was designed to be a project handbook -- containing information about transition criteria for development activities, configuration management, problem reporting, and communication protocol in addition to the requirements, design and coding standards. Table A.5 shows the relationship of the project data to each other and to their relevant life cycle processes.

Table A.4. Life Cycle Data for the GCS Project

Software Life Cycle Process	Software Life Cycle Data
<i>Software Planning</i>	<ul style="list-style-type: none"> • Plan for Software Aspects of Certification including: Software Development Plan • Software Development Standards including: Software Requirements Standards Software Design Standards Software Code Standards • Software Configuration Management Plan • Software Quality Assurance Plan • Software Verification Plan
<i>Software Development</i>	
Transitional Software Requirements	• GCS Specification (Software Requirements Data)
Transitional Software Design	<ul style="list-style-type: none"> • Design Description for Mercury • Design Description for Pluto
Software Coding	<ul style="list-style-type: none"> • Source Code for Mercury • Source Code for Pluto
Integration	<ul style="list-style-type: none"> • Executable Object Code for Mercury • Executable Object Code for Pluto
<i>Integral</i>	
Software Verification	<ul style="list-style-type: none"> • Software Verification Cases and Procedures including: Requirements-based Test Cases • Software Verification Results including: Structure-based Test Cases for Mercury Structure-based Test Cases for Pluto
Configuration Management	<ul style="list-style-type: none"> • Software Configuration Index including: Software Life Cycle Environment Configuration Index • Software Configuration Management Records • Problem Reports for Mercury • Problem Reports for Pluto • Support Documentation Change Reports
Software Quality Assurance	• Software Quality Assurance Records
	• Software Accomplishment Summary

Table A.5. Relationship of Life Cycle Data

Inputs	Life Cycle Process	Outputs
DO-178B	Software Planning	Plan for Software Aspects of Certification Software Development Standards Software Verification Plan Software Configuration Management Plan Software Quality Assurance Plan
GCS specification (as delivered from RTI)	Requirements	GCS specification version 2.2
GCS specification version 2.2 Software Development Standards Design Descriptions (as delivered from RTI)	Design*	Design Description for Mercury Design Description for Pluto
GCS specification Design Descriptions for Mercury and Pluto Software Development Standards	Code*	Source Code for Mercury Source Code for Pluto
Source Code for Mercury and Pluto Software Verification Cases and Procedures (including Requirements-based and Structure-based Test Cases)	Integration*	Executable Object Code for Mercury Executable Object Code for Pluto
DO-178B GCS specification Software Verification Plan Design Descriptions for Mercury and Pluto Source Code for Mercury and Pluto	Verification	Software Verification Cases and Procedures Software Verification Results for Mercury Software Verification Results for Pluto
DO-178B Software Configuration Management Plan All life cycle data	Configuration Management	Software Configuration Index (including the Life Cycle Environment Index) Problem Reports for Mercury Problem Reports for Pluto Support Documentation Change Reports Configuration Management Records
DO-178B Software Quality Assurance Plan All life cycle data	Software Quality Assurance	SQA Records

* Note that for these development processes, although the inputs and outputs for those processes have been grouped together in Table A.5, the actual development processes were carried out independently by the separate development teams for the Mercury and Pluto implementations.

A.6 Additional Considerations

Without system requirements, certain assumptions were made in the development of the software requirements. Without system requirements, there also was no system safety assessment which is an important aspect of any development process that needs to comply with the DO-178B guidelines. Lack of system requirements also impacts the extent to which the project will comply with the DO-178B guidelines because no traces were made from the software requirements back

to the system requirements and safety assessment. These considerations are the same as those described in the *Plan for Software Aspects of Certification*.

A.7 Software Identification

The following tables contain the software configuration with respect to the current configuration identification and version number for the Mercury and Pluto implementations of the GCS. This is the identification of the elements as they are to be delivered to the certification authority. For each code component, the most recent version number and corresponding date when that component was placed under configuration control are given along with references to the problem reports to are related to the changes for that code component.

Table A.6: Mercury Source and Executable Object Code Components

Source Code DISK\$HOKIE:[GCS.CMS.SOURCE_CODE.MERCURY]	Version #	Date	Related Problem Reports
aeclp.for	3	12/14/94	25, 26
asp.for	4	3/24/95	25, 26, 30
cp.for	4	12/29/94	25, 26, 27
excond.inc	3	12/14/94	25, 26
gsp.for	3	12/14/94	25, 26
param.inc	3	12/14/94	25, 26
tdlrsp.for	3	12/14/94	25, 26
tsp.for	3	12/14/94	25, 26
arsp.for	3	12/14/94	25, 26
common.inc	3	12/14/94	25, 26
crep.for	3	12/14/94	25, 26
gp.for	5	3/24/95	25, 26, 28, 30
mercury.for	3	12/14/94	25, 26
reclp.for	3	12/14/94	25, 26
tdsp.for	3	12/14/94	25, 26
Executable Object Code DISK\$HOKIE:[GCS.CMS.EXEC_OBJ_CODE.MERCURY]			
mercury.exe	1	3/6/95	
build_mercury.com	1	3/6/95	

Although there were a total 6 problem reports issued for the Mercury source code (PRs # 25 - 30), PR #29 did not result in any change to the source code. For the Pluto implementation, a total of 6 problem reports were also issued (PRs #23 - 28), each resulting in some change to the source code.

Table A.7: Pluto Source and Executable Object Code Components

Source Code DISK\$HOKIE:[GCS.CMS.SOURCE_CODE.PLUTO]	Version #	Date	Related Problem Reports
aeclp.for	4	4/6/95	23, 24, 28
asp.for	5	4/6/95	23, 24, 27, 28
constants.for	4	4/6/95	23, 24, 28
crep.for	4	4/6/95	23, 24, 28
gp.for	5	4/6/95	23, 24, 27, 28
gsp.for	4	4/6/95	23, 24, 28
pluto.for	5	4/6/95	23, 24, 26, 28
run_parameters.for	4	4/6/95	23, 24, 28
spsf.for	4	4/6/95	23, 24, 28
tdsp.for	4	4/6/95	23, 24, 28
utility.for	4	4/6/95	23, 24, 28
arsp.for	4	4/6/95	23, 24, 28
clpsf.for	5	4/6/95	23, 24, 26, 28
cp.for	5	4/6/95	23, 24, 25, 28
external.for	4	4/6/95	23, 24, 28
gpsf.for	4	4/6/95	23, 24, 28
guidance_state.for	4	4/6/95	23, 24, 28
reclp.for	4	4/6/95	23, 24, 28
sensor_output.for	4	4/6/95	23, 24, 28
tdlrsp.for	4	4/6/95	23, 24, 28
tsp.for	4	4/6/95	23, 24, 28
Executable Object Code DISK\$HOKIE:[GCS.CMS.EXEC_OBJ_CODE.PLUTO]			
pluto.exe	1	6/1/95	
p_build.com	1	6/1/95	

A.8 Change History

Problem Reporting for the GCS project was divided into 2 distinct areas: reports for software products and reports for support documentation. The life cycle data items contained in each of these categories are listed in Table A.8 and A.9. The life cycle data in the development products and support documentation categories are all under CC1. A unique problem and change reporting system was established for each category. Two different reporting systems were used because, from an experiment perspective, we wanted to collect additional information about the errors in the development products than was required by DO-178B. In general, information on changes

made to the support documentation was not a focus of the experiment. Further information about the problem reporting procedures and forms can be found in the *Software Development Standards* and the *Software Configuration Management Plan*.

Table A.8. Development Products

Design Description
Source Code
Executable Object Code

Table A.9. Support Documentation

Plan for Software Aspects of Certification
Software Development Plan
Software Requirements Standards
Software Design Standards
Software Code Standards
Software Accomplishment Summary
Software Verification Plan
Software Verification Cases and Procedures
Software Quality Assurance Plan
Software Configuration Management Plan
Software Life Cycle Environment Configuration Index
Software Configuration Index
Software Requirements Data

A.8.1 Summary of Development Activities and Problem Reports

The following tables contain brief summaries of the development activities and problem reports issued for the Mercury and Pluto implementations of GCS. Tables A.10 and A.11 give the development and problem report summaries for the Mercury implementation and Tables A.12 and A.13 give the summaries for the Pluto implementation. For the problem report summaries, the following information is given in the tables:

- the development product in which the problem was first identified (Design, Source Code, Executable Object Code)
- specific code components affected by the change (including Introduction, High-level Diagrams, Functional Units, and Data Dictionary)

The functional units are:

Axial Engine Control Law Processing (AECLP),
Altimeter Radar Sensor Processing (ARSP),
Accelerometer Sensor Processing (ASP),
Communications Processing (CP),
Chute Release Control Processing (CRCP),
Guidance Processing (GP),
Gyroscope Sensor Processing (GSP),
Roll Engine Control Law Processing (RECLP),
Touch Down Landing Radar Sensor Processing
(TDLRSP),
Touch Down Sensor Processing (TDSP), and
Temperature Sensor Processing (TSP).

- activity that enabled the discovery of the problem (Design Review, Code Review, Testing, Requirements change, or Other)
- brief description of the problem (Missing, Unnecessary or Incorrect Functionality; Ambiguity in information, comments or syntax; Cosmetics including typographical and grammatical errors; and Noncompliance with standards)
- related change reports

Note that a number of specific problems were often addressed in a single problem report. Although combining multiple problems into one report makes description of the problems cumbersome, it was considered necessary to reduce the amount of paperwork involved in the change control process, especially when a large number of problems were identified in the early review sessions. For further information on the problem descriptions, see the problem reports for each specific GCS implementation.

Table A.10. Summary of Mercury Development Activities

Development Phase	Dates	Product	Verification Activities	Related Problem Reports
Design	11/93 - 5/31/94	Preliminary Design	<ul style="list-style-type: none"> Preliminary Design Review: Overview 12/2/93 6 Review Sessions 12/7-10/93 	PRs #1 -13
			<ul style="list-style-type: none"> GCS specification mod SDCR 2.3-2 	PR# 14
	5/31/94 - 8/30/94	Design	<ul style="list-style-type: none"> Design Review: Overview 6/3/94 2 Review Sessions: 6/29/94 	PRs #15 - 22
			<ul style="list-style-type: none"> GCS specification mod SDCR 2.3-4 	PR# 23
Code	8/30/94 - 12/10/94	Mercury Source Code	<ul style="list-style-type: none"> Programmer identified problems in design while developing code 	PR #24
			<ul style="list-style-type: none"> Code Review: Overview 10/4/94 2 Review Sessions 10/19/94 	PRs #25 - 26
Integration	12/10/94 - 4/15/95	Executable Object Code	<ul style="list-style-type: none"> GCS specification change SDCR #2.3-6 	PR #27
			<ul style="list-style-type: none"> Requirements-based Testing: Functional Unit Level Subframe Level Frame Level Trajectory Level 	PR #28
			<ul style="list-style-type: none"> Structure-based Testing 	PR #29 (determined to not be a problem)
			<ul style="list-style-type: none"> GCS specification mod SDCR #2.3-7 	PR #30

Table A.11. Summary of Problem Reports for Software Products for Mercury

PR #	Product	Product Component	Discovery Activity	Description	Related Reports
1	Preliminary Design	ASP	Design Review	Missing, Unnecessary, and Incorrect functionality, Ambiguity	
2	Preliminary Design	GSP	Design Review	Missing functionality, Cosmetics	
3	Preliminary Design	TSP	Design Review	Missing, Unnecessary, and Incorrect functionality, Ambiguity, Cosmetics	
4	Preliminary Design	ARSP	Design Review	Missing, Unnecessary, and Incorrect functionality, Ambiguity, Cosmetics	
5	Preliminary Design	TDLRSP	Design Review	Unnecessary and Incorrect functionality, Cosmetics	
6	Preliminary Design	TDSP	Design Review	Unnecessary and Incorrect functionality, Ambiguity	
7	Preliminary Design	GP	Design Review	Missing, Unnecessary, and Incorrect functionality, Ambiguity	
8	Preliminary Design	AECLP	Design Review	Missing, Unnecessary, and Incorrect functionality	
9	Preliminary Design	RECLP	Design Review	Missing, Unnecessary, and Incorrect functionality, Ambiguity	
10	Preliminary Design	CP	Design Review	Missing, Unnecessary, and Incorrect functionality, Ambiguity	
11	Preliminary Design	Data Dictionary	Design Review	Incorrect functionality, Ambiguity	
12	Preliminary Design	ASP, ARSP, CP	Design Review	Cosmetics	PRs # 1, 4, 10
13	Design	High-level Diagrams	Design Review	Incorrect functionality	PRs # 1 - 12
14	Design	ARSP, TDLRSP, CP	Requirements Change	Update to GCS specification mod (scheduling)	SDCR# 2.3-2
15	Design	High-level Diagrams	Design Review	Incorrect functionality, Ambiguity	PR #13
16	Design	High-level Diagrams, Data Dictionary	Design Review	Missing and Incorrect functionality	
17	Design	ASP, GSP, TSP, ARSP, TDLRSP, TDSP	Design Review	Unnecessary and Incorrect functionality	PRs #1, 2, 3, 4, 16
18	Design	GP	Design Review	Missing, Unnecessary, and Incorrect functionality, Ambiguity, Cosmetics	PR #7
19	Design	AECLP, RECLP	Design Review	Missing, Unnecessary, and Incorrect functionality	PRs #8, 9, 16
20	Design	CP	Design Review	Unnecessary and Incorrect functionality, Ambiguity	PR #10
21	Design	Complete Design	Design Review	Incorrect functionality (with respect to limit checks)	
22	Design	Data Dictionary, Introduction	Design Review	Cosmetics	
23	Design	ASP Data Dictionary	Requirements Change	Update to GCS specification mod (calculation of standard deviation & data dictionary entries)	SDCR# 2.3-4
24	Design	Complete Design	Generating code	Incorrect functionality	
25	Design, Code	Design & Code	Code Review	Incorrect functionality, Cosmetics	SDCR# 2.3-5
26	Code	Code	Code Review	Unnecessary functionality, Cosmetics	
27	Design, Code	CP	Requirements Change	Update to GCS specification mod	SDCR# 2.3-6
28	Design, Code	GP	Requirements-based testing (Functional unit level)	Incorrect functionality	PRs #7, 18
29	Code	RECLP	Generating structure-based test cases	problem was suspected but found not to be a problem	
30	Design, Code	ASP, GP	Requirements Change	Update to GCS specification mod (change in standard deviation and Tables 9 & 10)	SDCR# 2.3-7 SDCR# 2.3-4

Table A.12. Summary of Pluto Development Activities

Development Phase	Dates	Product	Verification Activities	Related Problem Reports
Design	11/93 - 6/29/94	Preliminary Design	<ul style="list-style-type: none"> Preliminary Design Review: Overview 8/26/93 9 Review Sessions 9/16/93 - 10/15/93 	PRs #1 -13
			<ul style="list-style-type: none"> GCS specification mod SDCR 2.3-2 	PR# 14
	6/29/94 - 8/26/94	Design	<ul style="list-style-type: none"> Design Review: 2 Review Sessions: 7/13/94 	PRs #15 - 19
Code	8/26/94 - 12/5/94	Pluto Source Code	<ul style="list-style-type: none"> GCS specification mod SDCR 2.3-4 	PR# 20
			<ul style="list-style-type: none"> Code Review: Overview 10/26/94 2 Review Sessions 11/16/94 	PRs #21 - 23
Integration	12/5/94 - 4/15/95	Executable Object Code	<ul style="list-style-type: none"> Requirements-based Testing: Functional Unit Level Subframe Level Frame Level Trajectory Level 	Prs #24 & 25 PR# 26 PR# 27
			<ul style="list-style-type: none"> Structure-based Testing 	

Table A.13. Summary of Problem Reports for Pluto

PR #	Product	Affected Component	Discovery Activity	Description of the Problem	Related Reports
1	Preliminary Design	Complete Design	Design Review	Noncompliance with standards (design did not balance)	
2	Preliminary Design	High Level Diagrams	Design Review	Unnecessary functionality	
3	Preliminary Design	TSP	Design Review	Unnecessary and Incorrect functionality, Ambiguity	
4	Preliminary Design	ARSP	Design Review	Missing and Unnecessary functionality, Ambiguity	
5	Preliminary Design	ASP	Design Review	Ambiguity	
6	Preliminary Design	GSP	Design Review	Incorrect functionality, Ambiguity	
7	Preliminary Design	TDLRSP	Design Review	Missing, unnecessary, and incorrect functionality, Ambiguity, and Cosmetics	
8	Preliminary Design	TDSP	Design Review	Unnecessary and Incorrect functionality	
9	Preliminary Design	RECLP	Design Review	Missing, Unnecessary, and Incorrect functionality, Ambiguity	
10	Preliminary Design	AECLP	Design Review	Missing, Unnecessary, and Incorrect functionality, Ambiguity	
11	Preliminary Design	CP	Design Review	Missing and Incorrect functionality, Ambiguity, Noncompliance with standards	
12	Preliminary Design	GP	Design Review	Missing, Unnecessary, and Incorrect functionality, Ambiguity	
13	Preliminary Design	High Level Diagrams, Data Dictionary	Design Review	Missing, Unnecessary, and Incorrect functionality, Ambiguity	
14	Design	ARSP, TDLRSP	Requirements change	Update to GCS specification mod (scheduling)	SDCR# 2.3-2
15	Design	ARSP, ASP, TDLRSP, TSP	Design Review	Missing, Unnecessary, and Incorrect functionality, Ambiguity	
16	Design	RECLP, AECLP, CRCP, CP	Design Review	Unnecessary and Incorrect functionality, Ambiguity, and Cosmetics	
17	Design	High Level Diagrams, Data Dictionary	Design Review	Missing and Incorrect functionality, , Ambiguity, Cosmetics	
18	Design	GP	Design Review	Missing, Unnecessary, and Incorrect functionality, Ambiguity	PR #17
19	Design	Complete Design	Design Review	Incorrect functionality, Ambiguity	
20	Design	High Level Diagrams, CP, Data Dictionary	Requirements Change	Update to GCS specification mod	SDCR# 2.3-4
21	Design	Introduction, High Level Diagrams, Data Dictionary	Code Review	Incorrect functionality, Cosmetics	PR #20
22	Design	Complete Design	Code Review	Unnecessary and Incorrect functionality, Ambiguity, Cosmetics	
23	Code	Complete Code	Code Review	Missing, Unnecessary, and Incorrect functionality, Cosmetics, Noncompliance with standards	
24	Code	ARSP, GP, RECLP, TDLRSP, TSP	Requirements-based Functional Unit Tests	Incorrect functionality	PR #23
25	Code	CP	Requirements-based Functional Unit Tests	Incorrect functionality	
26	Code	Subframe & Frame	Prep for Requirements-based Subframe & Frame Tests	Cosmetics	
27	Code	ASP, GP	Requirements-based Trajectory Tests	Incorrect functionality (negative square root problem) *** Initiated SDCR# 2.3-7	SDCR# 2.3-7
28	Code	Complete Code	Requirements-based Functional Unit Tests	Compiling problem (code was incorrectly transferred from one machine to another)	

A.9 Software Status

No problem reports for the software products from either the Mercury or Pluto implementations are unresolved; that is, all problem reports have been completed and approved. In fact, as per the transition criteria for the development processes, all problem reports issued during a given development process had to be completed and approved before the next development process could begin.

A.10 Compliance Statement

The development of the two GCS implementations proceeded for the mostpart as directed in the GCS project planning documents and proceeded, to the best of our understanding, in compliance with the standards in DO-178B. The two major deviations were in project personnel and schedule, with the changes in personnel having a substantial impact on the project schedule. The software development plan was executed as described in the *Plan for Software Aspects of Certification*. No further modifications of the software development products are planned.

A.11 References

- A.1 George B. Finelli. Results of software error-data experiments. In *AIAA/AHS/ASEE Aircraft Design, Systems and Operations Conference*, Atlanta, GA, September 1988.
- A.2 RTCA Special Committee 152. Software Considerations in Airborne Systems and Equipment Certification. Technical Report RTCA/DO-178A, Radio Technical Commission for Aeronautics, March 1985.

Appendix B: Software Configuration Index for the Guidance and Control Software Project

(includes the Software Life Cycle Environment Configuration Index)

Authors: Laura J. Smith and Kelly J. Hayhurst, NASA Langley Research Center

This document was produced as part of Guidance and Control Software (GCS) Project conducted at NASA Langley Research Center. Although some of the requirements for the Guidance and Control Software application were derived from the NASA Viking Mission to Mars, this document does not contain data from an actual NASA mission.

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B.1 Introduction

The Software Configuration Index (SCI) functions as a master list for the configuration of items under configuration control for the Guidance and Control Software (GCS) project. The Software Life Cycle Environment Configuration Index (SECI) identifies the configuration of the software life cycle environment. This document contains both the Software Configuration Index and the Software Life Cycle Environment Configuration Index as described in sections 11.16 and 11.15 of DO-178B, respectively.

The Software Configuration Index identifies the configuration of the software product. The SCI should identify the following:

- the software product;
- executable object code;
- each source code component;
- software life cycle data;
- archive and release media;
- instructions for building the executable object code;
- procedures used to recover the software for regeneration, testing, or modification;
- reference to the Software Life Cycle Environment Configuration Index if packaged separately; and
- data integrity checks for the executable object code, if used.

Configuration management for on-line files for GCS is aided by the DEC Code Management System (CMS) (ref. B.1). For more information on how CMS is being used during this project, refer to the *Software Configuration Management Plan*. A complete list of tools used in the GCS project can be found in the Software Life Cycle Environment section of this document.

B.2 Software Product

For the purpose of the GCS project, the software product refers to executable object code, each source code component, and the software life cycle data. The following sections describe each component of the software product in further detail.

B.2.1 Executable Object Code

The executable object code will not be placed under configuration control until the integration phase of development is complete. For all of the testing during the integration phase, the source code will be fetched from CMS and the executable object code will be generated as defined in the Software Verification Procedures. Once all testing is complete, the executable object code will be generated using the appropriate build files for each implementation (see section “Instructions for Building Executable Object Code”) and placed in the designated CMS library (see Table B.3).

B.2.2 Source Code Components

Two implementations (referred to as Mercury and Pluto) of the GCS are being developed independently for this project. Table B.1 lists the source code components for Mercury and Table B.2 lists the source code components for Pluto. Each implementation has its own CMS library which is located in the VMS directory DISK\$HOKIE:[GCS.CMS.SOURCE_CODE.*planet*] where *planet* refers to Mercury or Pluto. The individual source code components are located in this library for each implementation.

Table B.1: Mercury Source Code Components

Library: DISK\$HOKIE:[GCS.CMS.SOURCE_CODE.MERCURY]	
aeclp.for	arsp.for
asp.for	common.inc
cp.for	crclp.for
excond.inc	gp.for
gsp.for	mercury.for
param.inc	reclp.for
tdlrsp.for	tdsp.for
tsp.for	

Table B.2: Pluto Source Code Components

Library: DISK\$HOKIE:[GCS.CMS.SOURCE_CODE.PLUTO]	
aeclp.for	arsp.for
asp.for	clpsf.for
constants.for	cp.for
crclp.for	external.for
gp.for	gpsf.for
gsp.for	guidance_state.for
pluto.for	reclp.for
run_parameters.for	sensor_output.for
spsf.for	tdlrsp.for
tdsp.for	tsp.for
utility.for	

B.2.3 Software Life Cycle Data

For the GCS project, the general plan for configuration management is to use a set of software tools, already available at Langley, and some paper forms to identify, control, baseline, and archive all life cycle data associated with the development of the GCS implementations. Table B.3 gives a list of the life cycle data for the GCS project as discussed in Section 11 of the DO-178B guidelines plus additional life cycle data as required by the project. This life cycle data consists of planning and support documents and the actual products from the software

development process (e.g., design description and source code). Configuration management is responsible for maintaining all changes made to this life cycle data throughout the GCS project.

Table B.3. Life Cycle Data for the GCS Project

Software Life Cycle Data	Configuration Item	Storage Medium ^(a)
Plan for Software Aspects of Certification Software Development Plan	Plan for Software Aspects of Certification	CERT_PLAN
Software Verification Plan	Verification Plan Software Requirements Traceability Data	VER_PLAN TRACE_DATA
Software Configuration Management Plan	Configuration Management Plan	CM_PLAN
Software Quality Assurance Plan	Software Quality Assurance Plan	SQA_PLAN
Software Requirements Standards Software Design Standards Software Code Standards	Software Development Standards	DEV_STAND
Software Requirements Data	GCS Specification	SPEC
Design Description	Teamwork Model* Design Overview*	DES_DESCRIP.planet
Source Code	Source Code*	SOURCE_CODE.planet
Executable Object Code	Executable Object Code*	EXEC_OBJ_CODE.planet
Software Verification Cases and Procedures	Verification Cases* Verification Procedures	VER_CASES VER_PROC
Software Verification Results	Verification Results*	VER_RESULTS.planet
Software Life Cycle Environment Configuration Index; Software Configuration Index	Configuration Index	CONFIG_INDEX
Problem Reports	Problem and Action Reports* Support Document Change Reports Formal Modifications to the Specification ^(b)	paper forms paper forms SPEC_MODS
Software Configuration Management Records	Configuration Management Records*	paper forms
Software Quality Assurance Records	Software Quality Assurance Records*	paper forms
Software Accomplishment Summary	Software Accomplishment Summary	ACCOMP_SUM
Simulator User's Guide	Simulator User's Guide	SIMULATOR.USER_GUIDE
Simulator Source Code	Simulator Source Code	SIMULATOR.SOURCE_CODE

^(a) All CMS libraries are located in DISK\$HOKIE:[GCS.CMS.xxx] where xxx is specified under storage medium.

^(b) Formal modifications 2.2-1 through 2.2-26 of the GCS Specification were not recorded in Support Documentation Change Reports (SDCR). All remaining modifications to the GCS Specification will be recorded on an SDCR form.

* These configuration items will be implementation specific, the labels should refer to the implementation as appropriate.

B.2.4 Archive and Release Media

The items under configuration management using CMS for the GCS project are kept on-line on a DEC VAX cluster, running the VMS operating system. The following describes the backups of this system to ensure the integrity of the data:

- a full backup of all items located on the system will be performed once a week;
- a duplicate copy will be made of each full backup tape and stored in a physically separate archive to minimize the risk of loss in the event of a disaster;
- no unauthorized changes can be made to any of the backup tapes;
- all tapes will be verified for regeneration errors (by using the backup/verify command);
- incremental backups are run on a daily basis for a four week cycle to lessen the probability of losing any information.

After a full backup has been performed, a duplicate copy of the tape will be made. The duplicate tapes are verified when copied to ensure that accurate copies have been produced. The components of the GCS project will be authorized for release to the certification authority after the integration testing has been completed. All data will be archived for future references.

Since Problem Reports and Support Documentation Change Reports are not kept electronically, they will be archived in a binder by the configuration manager. Only PRs and SDCRs that have been approved and signed by the SQA representative will be archived. There will be separate binders labeled "Problem Reports for *Planet*", for each implementation, and "Change Reports". The SDCRs are organized by configuration item. See the section on "Configuration Status Accounting" in the *Software Configuration Management Plan* for more details on the binders.

B.2.5 Instructions for Building the Executable Object Code

The programmer for each implementation is responsible for the file that contains instructions for how all of the source code elements must be linked together in order to run the files. The Mercury build file is mercury_compile.txt. The Pluto build file is list_of_routines.txt. Each build file is stored in their respective CMS libraries, DISK\$HOKIE:[GCS.CMS.SOURCE_CODE.planet]. A copy of each build file is given in Appendix B.

B.2.6 Procedures Used to Recover the Software for Regeneration, Testing, or Modification

When a configuration item is requested from the Configuration Manager, it is placed in a VMS directory. However, not all of the project's life cycle data is developed or modified on the VAX system. For example, most of the planning and support documentation is developed using Microsoft Word on a Macintosh, and the implementations' designs are developed using a tool called *Teamwork* that runs on a SUN workstation. Some special instructions are needed to ensure that all project data can be regenerated and modified. The following subsections describe the procedures for transferring files to/from a VMS directory to their native format.

B.2.6.1 Instructions for Text Documents

Most of the planning documents are developed using Microsoft Word and these documents can be transferred to the VAX for configuration management using the FTP tool. The document must be transferred to the appropriate directory on the VAX system called AIR19 (all project members will have a valid account on this system). When transferring a Microsoft Word document using FTP, the options Image and MacBinary must be selected to ensure that the document can be regenerated as a Word document.

B.2.6.2 Instructions for Teamwork Models

As stated above, the *Teamwork* tool (running on a SUN workstation) is used to develop and modify the design description for each implementation. Preparing a *Teamwork* model for configuration management involves extracting the model from the *Teamwork* database and properly transferring the resulting file to AIR19. *Teamwork* models are either complete or incremental. A complete model contains all of its own objects; that is, it is self-contained, hence the term complete. An incremental model records only modifications made to objects stored in some other model; it is not self-contained. All *Teamwork* models under configuration management for the GCS project will be complete models. When archiving an incremental model, the incremental model as well as all referenced models must be archived as a unit in order to preserve the ability to reconstruct the incremental model.

The second column of the *Teamwork*'s "Model Processes Index" display indicates if a model is complete or incremental. When preparing a *Teamwork* model for configuration management, first complete the model if necessary.

Once the model is completed, the "dump_tsa" utility is invoked to extract the *Teamwork* model from the *Teamwork* database into a dump file. A dump file is merely an operating system file in a specific format. Once a dump file for the model has been created, the "dump" file should be transferred to AIR19. The FTP utility provides a convenient means for transferring the dump file. Note, the binary mode of FTP must be used in order to preserve the file integrity.

After requesting the *Teamwork* model from configuration management for testing or modification, the FTP utility can be used to transfer the *Teamwork* model from AIR19 to the machine which has *Teamwork* loaded. The binary mode of ftp should be invoked. Once the file containing the *Teamwork* model resides on the machine, the "load_tsa" utility should be used to load the dump file into *Teamwork*.

B.2.6.3 Instructions for Source Code and Test Cases

The source code and test cases are created either on a VAX or on a SUN, depending on the participants workstation. For those cases where source code or test cases are created on the SUN, the files are transferred to AIR19 (the development workstation) via the FTP utility for compilation, linking, executing, etc. No special conversion instructions are necessary before storing the files in CMS.

B.2.6.4 Native Format of Configuration Items

Table B.4 shows the configuration items along with the format in which they are stored in the CMS libraries, if applicable. Some of the configuration items are only kept in paper form; these will be archived and available for future references.

Table B.4: Native Format of Configuration Items

Configuration Items	Format
Plan for Software Aspects of Certification	Microsoft Word
Verification Plan	Microsoft Word
Software Requirements Traceability Data	Microsoft Word
Configuration Management Plan	Microsoft Word
Software Quality Assurance Plan	Microsoft Word
Software Development Standards	Microsoft Word
GCS Specification	Microsoft Word
Teamwork Model	Teamwork
Design Overview	Microsoft Word
Source Code	FORTRAN
Executable Object Code	VMS Executable Image
Verification Cases	models: Mathematica test cases: ASCII
Verification Procedures	Microsoft Word
Verification Results	Microsoft Word
Configuration Index	Microsoft Word
Problem and Action Reports	paper
Support Document Change Forms	paper
Formal Modifications to the Specification	Microsoft Word
Configuration Management Records	paper
Software Quality Assurance Records	paper
Software Accomplishment Summary	Microsoft Word
Simulator User's Guide	Microsoft Word
Simulator Source Code	FORTRAN

B.3 Software Life Cycle Environment Configuration Index

The Software Life Cycle Environment Configuration Index (SECI) identifies the configuration of the software life cycle environment. This index is written to aid reproduction of the hardware and software life cycle environment for software regeneration, reverification, or modification, and should identify the following:

- the software life cycle environment hardware and its operating system software;
- the software development tools, such as compilers, linkage editors and loaders, and data integrity tools;
- the test environment used to verify the software product; and
- qualified tools and their associated tool qualification data.

B.3.1 Software Life Cycle Environment Hardware and its Operating System

Since the development of the GCS implementations is part of a research project, the development environment for the software is the same as the target environment of the implementations; that is, the GCS implementations will not be included in a "real" hardware system intended for space flight. The environment for most of the software development of the GCS implementations is a microVAX 3800 computer system (referred to as AIR19). However, the *Teamwork* software is located on a Sun 4/310C machine which runs SunOS 4.1.3 (referred to as "kontiki"). Each of the project members has a personal computer available to him/her that may be used to connect to the other machines.

Table B.5 lists the operating system software and other support and development tools (and the associated version number) used for the GCS project.

Table B.5: Support and Development Tools

Software/Tools	Version
ACT	V19921201 #08CTS
CMS	V3.4
Mathematica	2.2
Microsoft Word - IBM	3.0C
Microsoft Word -Macintosh	5.1A or 6.0
Prototype Source Code	VENUS19
Simulator	GCS_SIM_2-17
SunOS	4.1.3
TCP/Connect	V1.2
Teamwork	4.1
VAX FORTRAN ^(a)	V5.5-98
VAX-11 linker ^(b)	V05-13
VAX/VMS Operating System	V5.5-2
VAXnotes	V2.0

^(a) the compiler ^(b) includes the loader

B.3.2 Software Development Tools

A number of tools are used to aid in the development of the software product, especially with respect to the design description and source code. The following sections describe the tools which were used for the software development of the GCS project.

B.3.2.1 Teamwork

For the GCS project, each programmer is required to use the Computer Aided Software Engineering (CASE) tool, *Teamwork* (ref. B.2), to develop their detailed design description. *Teamwork*, which is a product of Cadre Technologies, Inc., is a set of software engineering tools based on the structured methods of Hatley and DeMarco (ref. B.3). The *Teamwork* tools can be used to create and edit functional specifications consisting of data flow diagrams, control flow

diagrams and event-driven constructs, process specifications, and data dictionary. For the GCS project, each programmer had the opportunity to use either of the following *Teamwork* components to develop their design:

SA/RT-- the baseline structured analysis tool with an extension that allows description of real-time systems (ref. B.4), or

SD -- a parallel tool that follows the Ward and Mellor approach to design (ref. B.5).

Both programmers chose the SA/RT tool to implement their design. The design description developed using *Teamwork* is required for the design and code reviews.

B.3.2.2 FORTRAN

Although there are a variety of programming languages available for use, requirements for this project preclude a programmer from using any language except FORTRAN for the purposes of this project.

VAX FORTRAN (ref. B.6) is an implementation of full language FORTRAN-77 conforming to American National Standard FORTRAN. It includes optional support for programs conforming to the previous standard. VAX FORTRAN meets the Federal Information Processing Standard Publication requirements by conforming to the ANSI Standard.

The VAX/VMS FORTRAN compiler creates object code which can then be linked into an executable image. The shareable, reentrant compiler operates under the VAX/VMS Operating System. It globally optimizes source programs while taking advantage of the floating point and character string instruction set and the VMS virtual memory system.

The primary editor used on the VAX system to edit source code and test cases is the VAX/VMS default editor, VAX EDT (ref. B.7). The other editor used for files on the VAX system is the VAX Text processing Utility (VAXTPU) (ref. B.8).

B.3.3 Test Environment

The following sections describe the tools which were used by the verification analysts to aid them in the verification of the implementations.

B.3.3.1 Mathematica

Mathematica (ref. B.9) is a general computer software system and language intended for mathematical modeling and calculations. It supports numerical, symbolic, and graphical computation. It can be used both as an interactive problem solving environment and as a modern high-level programming language. Although Mathematica has numerous uses, for the GCS project it will be used only as:

- a numerical and symbolic calculator,
- a high-level programming language, and
- a modeling and data analysis environment.

To independently verify the correctness of sensor, position, and control calculations produced during testing, Mathematica will be used to model the computations of each functional unit and calculate the expected results. For test cases which generate output that, according to DO-178B,

must be compared with independently calculated values, the verification analysts will develop a program that compares the test output with the expected values derived from Mathematica models. This analysis program will generate a comparison file which can then be evaluated for problems.

B.3.3.2 ACT

The tool ACT, Analysis of Complexity Tool (ref. B.10), is based on McCabe's Cyclomatic Complexity Metric Method (ref. B.11). ACT examines the structure of a source code module and produces a flow graph based on that structure and identifies all possible paths through the code. This tool will be used to aid in structural test case development and structural coverage analysis.

B.3.3.3 Simulator

The GCS simulator is an environment developed to allow researchers to study the behavior of software and to develop insight into the origin of software errors and the effects of these errors on software reliability. The simulator generates input for one or more implementations of the guidance and control software and acts upon their output to model the behavior of a planetary lander during the terminal descent phase of landing. It also provides access to and analysis of important data generated by the implementations so that potential software failures are detected and noted for the researcher to further investigate. The simulator is composed of executable, input, and output files. The files that compose the simulator are listed in Appendix A under the library [GCS.CMS.SIMULATOR.SOURCE_CODE].

B.3.3.4 Prototype Source Code

A prototype implementation of the GCS was developed in conjunction with the GCS specification and simulator. The prototype implementation was written in FORTRAN-77, but was not written in compliance with any particular software development standards.

B.3.4 Configuration Management Tools

For the purposes of the GCS project, DEC/CMS (Code Management System) will be used for the configuration management of all software product data. CMS (ref. B.1) is a software library system that facilitates the development and maintenance of software systems. Software systems are divided into different functional components that are, in turn, organized into sets of one or more files. CMS helps manage the files during development, and later during maintenance, by storing the files in a project library, tracking changes, and monitoring access to the library. CMS also supplies a means of manipulating different combinations of files within a library. The ability to formalize these combinations provides a focus for system design and a means of organizing the files within a library. Through the use of CMS, programmers will be able to recreate any version of their code at any stage during its development; any version of the support documentation can also be regenerated. Appendix A lists each CMS library and its contents for all project data that is stored electronically.

B.3.5 Other Tools

A number of tools will be used by the GCS project participants to interact, distribute information electronically, and document activities throughout the project. Although most of the communication on the GCS project is done informally through verbal communication or

electronic mail, a few tools will be used to document certain project communication, namely requests for configuration management services and problem and action reporting.

B.3.5.1 VAX Notes

VAX Notes (ref. B.12) is a computer conferencing software product designed to provide users with the capability of creating and accessing on-line conferences or meetings. Computer conferencing is an electronic messaging technology which lets users conduct meetings with people in different geographic locations via computer so that participants can join in a discussion from their own desk at a time of their own choice.

VAX Notes will be used in order to collect data for the purpose of the experiment (not for certification). All questions about the GCS specification should be addressed to the system analyst. It is especially important to capture the questions that the programmers ask the system analyst about the specification and the response from the system analyst. All questions to the system analyst should be specific to the GCS specification as opposed to questions about implementation specific issues. Additionally, the programmers and verification analysts should use VAX Notes when making requests for elements from the configuration manager.

B.3.5.2 Problem Reporting

Problem and Action Reports are used to document all information pertaining to problems identified in any of the development product (design, source code, or executable object code) and Support Documentation Change Reports are used to document modifications to all support documents. Copies of these reports are shown in the *Software Configuration Management Plan*.

B.3.5.3 File Transfer Protocol

The File Transfer Protocol (FTP) transfers files between two host systems. There are two ways in which FTP is used to retrieve a file from a remote host for the GCS project. The first begins when the user initiates a connection to the remote host by entering the command "FTP host address", where a systems is specified in place of "host address". This requires the user to know how to change to the required directory and also how to tell the host system the required action. The second way to initiate FTP is by using the TCP/IP connection that is available on the Macintoshes; this connection uses a series of pull-down menus and command boxes.

B.3.6 Qualified Tools

Since the GCS project is a research effort with limited resources, the qualification of the tools used on this project was not attempted.

B.4 CMS Libraries

The following lists each CMS library (and its contents) as of 6/4/95. In some libraries, there are groups and subgroups; these will be noted under the library column with the format of GROUP/SUBGROUP(/SUBGROUP)

CMS Library	Elements
DISK\$HOKIE:[GCS.CMS.ACCOMP_SUM]	
DISK\$HOKIE:[GCS.CMS.CERT_PLAN]	cert_plan.txt
DISK\$HOKIE:[GCS.CMS.CM_PLAN]	cm_plan.txt
DISK\$HOKIE:[GCS.CMS.CONFIG_INDEX]	
DISK\$HOKIE:[GCS.CMS.DES_DESCRIP.MERCURY]	design.overview_intro
	design.overview_labels
	design.overview_preface
	design.teamwork
	gcs_design.ps
	mercury_design.
DISK\$HOKIE:[GCS.CMS.DES_DESCRIP.PLUTO]	design.overview
	design.teamwork
DISK\$HOKIE:[GCS.CMS.DEV_STAND]	dev_standards.txt
DISK\$HOKIE:[GCS.CMS.EXEC_OBJ_CODE.MERCURY]	build_mercury.com
	mercury.exe
DISK\$HOKIE:[GCS.CMS.EXEC_OBJ_CODE.PLUTO]	pluto.exe
	p_build.com
DISK\$HOKIE:[GCS.CMS.SIMULATOR.SOURCE_CODE]	accuracy.dat
	accuracy.for_inc
	accuracy_definitions.for_inc
	alternate_accuracy.dat
	alt_check_external.for
	alt_check_guidance.for
	alt_check_sensors.for
	alt_compare_ae_cmd.for
	alt_compare_real8.for
	build_create_init_data.com
	build_gcs_sim.com
	build_gcs_sim_nocms.com
	build_rendezvous.com
	build_rendezvous_debug.com
	calculate_values.for
	check_cp.for
	check_external.for
	check_guidance.for
	check_paramenters.for
	check_sensors.for
	check_stat.for
	check_timing.for
	cms_fetch.for
	common_record.for_inc
	common_switches.for_inc
	compare_ae_cmd.for
	compare_int2.for

CMS Library	Elements
DISK\$HOKIE:[GCS.CMS.SIMULATOR.SOURCE_CODE]	compare_int4.for
	compare_log1.for
	compare_mask.for_inc
	compare_real8.for
	complete_ast.for
	crc.for
	create_init_data.com
	create_init_dat.for
	create_init_data_a.com
	create_init_data_b.com
	doid_defs.for_inc
	do_assigns.com
	gcs_com.for_inc
	gcs_int_cvt.for
	gcs_list.dat
	gcs_params.for_inc
	gcs_rendezvous.mms
	gcs_setup.for
	gcs_setup.obj
	gcs_sim.mms
	gcs_sim_rendezvous.for
	gcs_sim_rendezvous.obj
	gcs_sim_switches.dat
	gcs_sim_switches.for_inc
	gcs_who_am_i.for
	gcs_who_am_i.obj
	generate_initial_random_seed.for
	get_accuracy_data.for
	get_data.for
	get_init_data.for
	get_switches.for
	global_setup.for
	initialize.for
	initial_attitude.for
	initial_contants.dat
	initial_contants_1.dat
	initial_contants_2.dat
	initial_contants_3.dat
	initial_contants_4.dat
	initial_contants_5.dat
	initial_contants_6.dat
	initial_contants_7.dat
	initial_contants_8.dat
	initial_seed.dat
	init_base_vals.for
	init_timing.for
	integrate.for
	limits.dat
	limits.for_inc
	limit_check.for

CMS Library	Elements
DISK\$HOKIE:[GCS.CMS.SIMULATOR.SOURCE_CODE]	log_traj_status.for
	log_values.for
	loop_values.for
	matrix_multiply.for
	mms_rules.mms
	mod_data.exe
	mod_data.for
	packet_definitions.for_inc
	page_align.opt
	passed_record.for_inc
	pg_align_sim.opt
	put_data.for
	put_init_data.for
	random.for
	random_value.for
	release.for
	report_in.for
	response_model.for
	rti_traj_sim.exe
	runsimi.com
	start_gcs_models.for
	stop_jobs.for
	table_lookup.for
	tabular_data.dat
	thrusters.for
	traj_sim.exe
	traj_sim.for
	traj_sim_debug.exe
	twos_comp.for
	ufo_create.for
	update.for
	usage_distributions.dat
	who_is_waiting.for
DISK\$HOKIE:[GCS.CMS.SIMULATOR.USER_GUIDE]	
DISK\$HOKIE:[GCS.CMS.SOURCE_CODE.MERCURY]	aeclp.for
	arsp.for
	asp.for
	common.inc
	cp.for
	crep.for
	excond.inc
	gp.for
	gsp.for
	mercury.for
	mercury_compile.txt
	param.inc
	reclp.for
	tdlrsp.for
	tdsp.for
	tsp.for

CMS Library	Elements
DISK\$HOKIE:[GCS.CMS.SOURCE_CODE.PLUTO]	aeclp.for arsp.for asp.for clpsf.for constants.for cp.for crcp.for external.for gp.for gpsf.for gsp.for guidance_state.for list_of_routines.txt pluto.for reclp.for run_parameters.for sensor_output.for spsf.for tdlrsp.for tdsp.for tsp.for utility.for
DISK\$HOKIE:[GCS.CMS.SPEC]	spec_2_1.txt spec_2_2.txt spec_2_3.txt
DISK\$HOKIE:[GCS.CMS.SPEC_MODS]	mod_2_2-1 --> 29.txt fm_2_3-1 --> 7.txt
DISK\$HOKIE:[GCS.CMS.SQA_PLAN]	sqa_plan.doc sqa_plan.ps
DISK\$HOKIE:[GCS.CMS.TRACE_DATA]	reqtrdat.doc
DISK\$HOKIE:[GCS.CMS.VER_CASES]	
FRAME	frame_001 --> 009.ex frame_001 --> 009.tc
FUNCTIONAL/DRIVERS	compare.for compare_external.for compare_guidance.for compare_packet.for compare_partial_external.for compare_runparam.for compare_sensor.for ex_cp.for m_clp_driver.com m_gpsf_driver.com m_lnkacclp.com m_lnkarsp.com m_lnkasp.com m_lnkclp.com m_lnkcp.com m_lnkcrep.com m_lnkframe.com

CMS Library	Elements
DISK\$HOKIE:[GCS.CMS.VER_CASES] FUNCTIONAL/DRIVERS	m_lnkgp.com
	m_lnkgpsf.com
	m_lnkmsp.com
	m_lnkreclp.com
	m_lnksp.com
	m_lnktdlrsp.com
	m_lnktdsp.com
	m_lnkmsp.com
	m_reclp_st.1 --> .3
	m_run_reclp_st.01 --> .03
	m_sp_driver.com
	m_st_driver.com
	m_tc_driver.com
	m_test_aeclp.for
	m_test_arsp.for
	m_test_asp.for
	m_test_clp.for
	m_test_cp.for
	m_test_crcp.for
	m_test_frame.for
	m_test_gp.for
	m_test_gpsf.for
	m_test_gsp.for
	m_test_reclp.for
	m_test_sp.for
	m_test_tdlrsp.for
	m_test_tdsp.for
	m_test_tsp.for
	p_buildall.com
	p_clp_driver.com
	p_compare_external.for
	p_compare_guidance.for
	p_compare_runpram.for
	p_compare_sensor.for
	p_ex_cp.for
	p_fordrivers.com
	p_frame_driver.com
	p_gpsf_driver.com
	p_lnkacclp.com
	p_lnkarsp.com
	p_lnkasp.com
	p_lnkclp.com

CMS Library	Elements
DISK\$HOKIE:[GCS.CMS.VER_CASES] FUNCTIONAL/DRIVERS	
	p_lnkcp.com
	p_lnkcrp.com
	p_lnkframe.com
	p_lnkgp.com
	p_lnkgpsf.com
	p_lnkgrp.com
	p_lnkrcp.com
	p_lnksp.com
	p_lnktdlrsr.com
	p_lnktdsp.com
	p_lnktsr.com
	p_read_ex.for
	p_read_tc.for
	p_run_aeclp.com
	p_run_arsr.com
	p_run_asr.com
	p_run_cp.com
	p_run_crp.com
	p_run_gp.com
	p_run_gsr.com
	p_run_rcp.com
	p_run_tdlrsr.com
	p_run_tdsp.com
	p_run_tsr.com
	p_sr_driver.com
	p_tc_driver.com
	p_test_aeclp.for
	p_test_arsr.for
	p_test_asr.for
	p_test_clp.for
	p_test_cp.for
	p_test_crp.for
	p_test_frame.for
	p_test_gp.for
	p_test_gpsf.for
	p_test_gsr.for
	p_test_rcp.for
	p_test_sr.for
	p_test_tdlrsr.for
	p_test_tdsp.for
	p_test_tsr.for
	read_ex.for

CMS Library	Elements
DISK\$HOKIE:[GCS.CMS.VER_CASES] FUNCTIONAL/DRIVERS	read_ex_integration.for
	read_tc.for
	run_aeclp.com
	run_aeclp_pst.com
	run_arsp.com
	run_tsp.com
FUNCTIONAL/MODELS	run_asp.com
	run_asp_pst.com
	run_clp.com
	run_cp.com
	run_crcp.com
	run_gp.com
	run_gpsf.com
	run_gp_pst.com
	run_gsp.com
	run_reclp.com
	exname_list.inc
	frame.m
	gp.m
	gp_pst7_code.m
	gp_tc.1 --> .117
	gsp.m
	input.
	m_aeclp_st.1 --> .3
	m_asp_st_001 --> 003.m
	m_gp_st.1 --> .9
	m_run_aeclp_st.01 --> .03
	m_run_gp_st.01 --> .11
	m_run_struct_reclp.01
	m_struct_reclp.tc
	m_tdlrsp_st_001 --> 011.m
	m_tsp_st_001.m
	namelist1.
	namelist_ex.
	name_list.inc
	reclp.m
	reclp_tc.1 --> .68
	reclp_tc.out
	run_aeclp.01 --> .57, .010, .1-10, .11-20, .21-30, .31-40, .41-47, .48-53, .48-57
	run_crcp.01 --> .10, .1-10
	run_gp., .01 --> .116, .1-10, .11-20, .21-30, .31-40, .41-50, .51-60, .61-70, .71-80, .81-90, .91-100, .101-110, .111-114, .111-116
	run_reclp.01 --> .68, .1-10, .11-20, .21-30, .31-40, .41-50, .51-60, .61-68
	run_gpsf.01 --> .08

CMS Library	Elements
DISK\$HOKIE:[GCS.CMS.VER_CASES] FUNCTIONAL/MODELS	sp.m
	tdlrsp.m
	tdsp.m
	tsp.m
	write_exnml.m
	write_exnml_st7.m
	write_nml.m
	write_nml_st7.m
FUNCTIONAL/NORMAL	aeclp_nr_001 --> 012, 054, 055.ex
	aeclp_nr_001 --> 012, 054, 055.tc
	arsp_nr_011 --> 017, 022, 023.ex
	arsp_nr_011 --> 017, 022, 023.tc
	asp_nr_001 --> 007, 016.ex
	asp_nr_001 --> 007, 016.tc
	cp_nr_001 --> 005.ex
	cp_nr_001 --> 005.tc
	crclp_nr_001 --> 006.ex
	crclp_nr_001 --> 006.tc
	gp_nr_001 --> 008, 053, 102 --> 106.ex
	gp_nr_001 --> 008, 053, 102 --> 106.tc
	gsp_nr_001.ex
	gsp_nr_001.tc
	reclp_nr_001 --> 059, 064 --> 068.ex
	reclp_nr_001 --> 059, 064 --> 068.tc
	tdlrsp_nr_001, 003, 005 --> 021.ex
	tdlrsp_nr_001, 003, 005 --> 021.tc
	tdsp_nr_001 --> 003.ex
	tdsp_nr_001 --> 003.tc
	tsp_nr_001 --> 003, 006, 007.ex
	tsp_nr_001 --> 003, 006, 007.tc
FUNCTIONAL/ROBUSTNESS	aeclp_ro_013 --> 053, 056, 057.ex
	aeclp_ro_013 --> 053, 056, 057.tc
	arsp_ro_001 --> 010, 018 --> 021.ex
	arsp_ro_001 --> 010, 018 --> 021.tc
	asp_ro_008 --> 015, 017 --> 044.ex
	asp_ro_008 --> 015, 017 --> 044.tc
	crclp_ro_007 --> 010.ex
	crclp_ro_007 --> 010.tc
	gp_ro_009 --> 052, 054 --> 101, 107 --> 117.ex
	gp_ro_009 --> 052, 054 --> 101, 107 --> 117.tc
	gsp_ro_002 --> 009.ex
	gsp_ro_002 --> 009.tc
	reclp_ro_060 --> 063.ex
	reclp_ro_060 --> 063.tc
	tdlrsp_ro_002, 004, 006, 022 --> 028.ex
	tdlrsp_ro_002, 004, 006, 022 --> 028.tc
	tdsp_ro_004 --> 007.ex
	tdsp_ro_004 --> 007.tc
	tsp_ro_004, 005, 008 --> 011.ex
	tsp_ro_004, 005, 008 --> 011.tc

CMS Library	Elements
DISK\$HOKIE:[GCS.CMS.VER_CASES] FUNCTIONAL/STRUCTURAL/MERCURY	m_aeclp_st_001 --> 003.ex
	m_aeclp_st_001 --> 003.tc
	m_arsp_st_001, 002.ex
	m_arsp_st_001, 002.tc
	m_asp_st_001 --> 006.ex
	m_asp_st_001 --> 006.tc
	m_cp_st_001.ex
	m_cp_st_001.tc
	m_gp_st_001 --> 011.ex
	m_gp_st_001 --> 011.tc
	m_reclp_st_001 --> 003.ex
	m_reclp_st_001 --> 003.tc
	m_tdlrsp_st_001 --> 009.ex
	m_tdlrsp_st_001 --> 009.tc
	m_tsp_st_001.ex
m_tsp_st_001.tc	
FUNCTIONAL/STRUCTURAL/PLUTO	aeclp_pst_001, 002.ex
	aeclp_pst_001, 002.tc
	asp_pst_001 --> 004.ex
	asp_pst_001 --> 004.tc
	gp_pst_001 --> 021.ex
	gp_pst_001 --> 021.tc
	reclp_pst_001 --> 011.ex
	reclp_pst_001 --> 011.tc
SUBFRAME	clp_001 --> 014.ex
	clp_001 --> 014.tc
	gpsf.com
	gpsf_001 --> 008.ex
	gpsf_001 --> 008.tc
	sp_001.ex
	sp_001.tc
TRAJECTORY	m_run_traj.com
	m_traj.com
	pluto.com
	run_mc.com
	run_traj.com
	traj.com
	traj_atm_001 --> 012.seed
	traj_atm_ic_001 --> 012.tc
	traj_atm_ud_001 --> 012.tc
	traj_td_013 --> 034.seed
	traj_td_ic_013 --> 034.tc
	traj_td_ud_013 --> 034.tc
DISK\$HOKIE:[GCS.CMS.VER_PLAN]	verplan.doc
DISK\$HOKIE:[GCS.CMS.VER_PROC]	procedures.
DISK\$HOKIE:[GCS.CMS.VER_RESULTS.MERCURY]	
DISK\$HOKIE:[GCS.CMS.VER_RESULTS.PLUTO]	

The following is a list of binders and their contents the configuration manager is keeping; the “Change Reports” binder is divided into sections.

Binder Name	Items
Problem Reports for Mercury	PR #1 - 31
Problem Reports for Pluto	PR #1 - 27
Change Reports:	
Configuration Management Plan	SDCR # 1 - 6
Development Standards	SDCR # 1 - 9
Spec	SDCR # 2.2-27 --> 29, 2.3-1 --> 7
Verification Cases	SDCR #1 - 38
Verification Plan	SDCR #1 - 8
Verification Procedures	SDCR #1

B.5 Build Files

Mercury Build File

The Mercury build file is located in
disk\$hokie:[gcs.cms.source_code.mercury]mercury_compile.txt and is as follows:

To compile the Mercury source code:

(generates one object file and one list file)

fortran/list mercury+tsp+arsp+asp+gsp+tdlrsp+tdsp+gp+aeclp+reclp+crclp+cp

(generates individual object files and individual list files)

fortran/list mercury,tsp,arsp,asp,gsp,tdlrsp,tdsp,gp,aeclp,reclp,crclp,cp

There are eleven(12) modules for Mercury with each module containing one or more subroutines.

DRIVER

mercury.for (include files: common.inc, excond.inc, param.inc)

SP

tsp.for (include files: common.inc, excond.inc, param.inc)

arsp.for (include files: common.inc, excond.inc, param.inc)

asp.for (include files: common.inc, excond.inc, param.inc)

gsp.for (include files: common.inc, excond.inc, param.inc)

tdlrsp.for (include files: common.inc, excond.inc, param.inc)

tdsp.for (include files: common.inc, param.inc)

GP

gp.for (include files: common.inc, excond.inc, param.inc)

CLP

aeclp.for (include files: common.inc, excond.inc, param.inc)

reclp.for (include files: common.inc, excond.inc, param.inc)

crclp.for (include files: common.inc, param.inc)

CP

cp.for (include file: common.inc)

Pluto Build File

The Pluto build file is located in disk\$hokie:[gcs.cms.source_code.pluto]list_of_routines.txt and is as follows:

<u>Module</u>	<u>Brief description</u>
AECLP.FOR	Implementation of functional unit AECLP
ARSP.FOR	Implementation of functional unit ARSP
ASP.FOR	Implementation of functional unit ASP
CLPSF.FOR	Contains the control for subframe 3
CONSTANTS.FOR	Data declarations for constants
CP.FOR	Implementation of functional unit CP
CRCP.FOR	Implementation of functional unit CRCP
EXTERNAL.FOR	Data definitions and Common block EXTERNAL
GP.FOR	Implementation of functional unit GP
GPSF.FOR	Contains the control for subframe 2
GSP.FOR	Implementation of functional unit GSP
GUIDANCE_STATE.FOR	Data definitions and Common block GUIDANCE_STATE
PLUTO.FOR	The Main program entry
RECLP.FOR	Implementation of functional unit RECLP
RUN_PARAMETERS.FOR	Data definitions and Common block RUN_PARAMETERS
SENSOR_OUTPUT.FOR	Data definitions and Common block SENSOR_OUTPUT
SPSF.FOR	Contains the control for subframe 1
TDLRSP.FOR	Implementation of functional unit TDLRSP
TDSP.FOR	Implementation of functional unit TDSP
TSP.FOR	Implementation of functional unit TSP
UTILITY.FOR	A collection of utility routines (range checking)

<u>To Build</u>	<u>Required Modules</u>
AECLP	AECLP.FOR, CONSTANTS.FOR, EXTERNAL.FOR, GUIDANCE_STATE.FOR, RUN_PARAMETERS.FOR, SENSOR_OUTPUT.FOR, UTILITY.FOR
ARSP	ARSP.FOR, CONSTANTS.FOR, EXTERNAL.FOR, GUIDANCE_STATE.FOR, RUN_PARAMETERS.FOR, SENSOR_OUTPUT.FOR, UTILITY.FOR
ASP	ASP.FOR, CONSTANTS.FOR, EXTERNAL.FOR, GUIDANCE_STATE.FOR, RUN_PARAMETERS.FOR, SENSOR_OUTPUT.FOR, UTILITY.FOR
CP	CP.FOR, EXTERNAL.FOR, GUIDANCE_STATE.FOR, RUN_PARAMETERS.FOR, SENSOR_OUTPUT.FOR
CRCP	CRCP.FOR, CONSTANTS.FOR, EXTERNAL.FOR, GUIDANCE_STATE.FOR

GP	GP.FOR, CONSTANTS.FOR, EXTERNAL.FOR, GUIDANCE_STATE.FOR, RUN_PARAMETERS.FOR, SENSOR_OUTPUT.FOR, UTILITY.FOR
GSP	GSP.FOR, CONSTANTS.FOR, EXTERNAL.FOR, GUIDANCE_STATE.FOR, RUN_PARAMETERS.FOR, SENSOR_OUTPUT.FOR, UTILITY.FOR
RECLP	RECLP.FOR, CONSTANTS.FOR, EXTERNAL.FOR, GUIDANCE_STATE.FOR, RUN_PARAMETERS.FOR, SENSOR_OUTPUT.FOR, UTILITY.FOR
TDLRSP	TDLRSP.FOR, CONSTANTS.FOR, EXTERNAL.FOR, GUIDANCE_STATE.FOR, RUN_PARAMETERS.FOR, SENSOR_OUTPUT.FOR
TDSP	TDSP.FOR, CONSTANTS.FOR, EXTERNAL.FOR, GUIDANCE_STATE.FOR, SENSOR_OUTPUT.FOR, UTILITY.FOR
TSP	TSP.FOR, CONSTANTS.FOR, EXTERNAL.FOR, GUIDANCE_STATE.FOR, RUN_PARAMETERS.FOR, SENSOR_OUTPUT.FOR, UTILITY.FOR
Subframe 1	ARSP.FOR, ASP.FOR, CP.FOR, GSP.FOR, SPSF.FOR, TDSP.FOR, TSP.FOR, CONSTANTS.FOR, EXTERNAL.FOR, GUIDANCE_STATE.FOR, RUN_PARAMETERS.FOR, SENSOR_OUTPUT.FOR, UTILITY.FOR
Subframe 2	CP.FOR, GP.FOR, GPSF.FOR, CONSTANTS.FOR, EXTERNAL.FOR, GUIDANCE_STATE.FOR, RUN_PARAMETERS.FOR, SENSOR_OUTPUT.FOR, UTILITY.FOR
Subframe 3	AECLP.FOR, CLPSF.FOR, CP.FOR, CRCP.FOR, RECLP.FOR, CONSTANTS.FOR, EXTERNAL.FOR, GUIDANCE_STATE.FOR, RUN_PARAMETERS.FOR, SENSOR_OUTPUT.FOR, UTILITY.FOR
Pluto	AECLP.FOR, ARSP.FOR, ASP.FOR, CLPSF.FOR, CP.FOR, CRCP.FOR, GP.FOR, GPSF.FOR, GSP.FOR, PLUTO.FOR, RECLP.FOR, SPSF.FOR, TDLRSP.FOR, TDSP.FOR, TSP.FOR, CONSTANTS.FOR, EXTERNAL.FOR, GUIDANCE_STATE.FOR, RUN_PARAMETERS.FOR, SENSOR_OUTPUT.FOR, UTILITY.FOR

B.6 References

- B.1 *Guide to VAX DEC/Code Management System.* Digital Equipment Corporation, Maynard, Massachusetts, April 1987.
- B.2 *Teamwork Environment Reference Manual.* Cadre Technologies, Inc., Providence, Rhode Island, Release 4.0, 1991.
- B.3 Hatley, Derek J.; and Pirbhai, Imtiaz A.: *Strategies for Real-Time System Specification.* Dorset House Publishing Company, New York, New York, 1987.
- B.4 *Teamwork/SA Teamwork/RT User's Guide.* Cadre Technologies, Inc., Providence, Rhode Island, Release 4.0, 1991.
- B.5 *Teamwork/SD User's Guide.* Cadre Technologies, Inc., Providence, Rhode Island, Release 4.0, 1991.
- B.6 *Programming in VAX FORTRAN.* Digital Equipment Corporation, Maynard, Massachusetts, September 1984.
- B.7 *Text Processing: EDT Reference Manual.* Digital Equipment Corporation, Maynard, Massachusetts, September 1984.
- B.8 *Text Processing: VAXTPU Reference Utility Manual.* Digital Equipment Corporation, Maynard, Massachusetts, April 1986.
- B.9 Wolfram, Stephen,. *Mathematica, A System for Doing Mathematics by Computer, Second Edition.* Addison-Wesley Publishing Company, Inc., 1991
- B.10 *Analysis of Complexity Tool User's Instructions,* McCabe Associates Inc., Redwood City, Ca., 1992
- B.11 McCabe, Thomas j., *Structural Testing: A Software Testing Methodology Using the Cyclomatic Complexity Metric,* McCabe & Associates, Inc., 1982.
- B.12 *Guide to VAX Notes.* Digital Equipment Corporation, Maynard, Massachusetts, March 1986

Appendix C: Configuration Management Records for the Guidance and Control Software Project

Authors: Laura Smith and Kelly J. Hayhurst, NASA Langley Research Center

This document was produced as part of Guidance and Control Software (GCS) Project conducted at NASA Langley Research Center. Although some of the requirements for the Guidance and Control Software application were derived from the NASA Viking Mission to Mars, this document does not contain data from an actual NASA mission.

C. Contents

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C.1 Introduction

This document contains the records of changes made to the life cycle data placed under configuration control in compliance with the Configuration Management Plan for the Guidance and Control Software project. Below is a table listing each of the life cycle data items under configuration control.

Table 1. DO-178B Life Cycle Data for the GCS Project

Software Life Cycle Data
Plan for Software Aspects of Certification *
Software Development Standards
Software Verification Plan
Software Configuration Management Plan
Software Quality Assurance Plan*
Software Requirements Data
Design Description for the Mercury Implementation
Design Description for the Pluto Implementation
Source Code for the Mercury Implementation
Source Code for the Pluto Implementation
Software Verification Cases and Procedures Document
Software Verification Results for the Mercury Implementation *
Software Verification Results for the Pluto Implementation*
Software Configuration Index *
Test Cases
Software Accomplishment Summary *

The * indicates that no revisions were made to that configuration item once it was placed under configuration control. The remainder of this document consists of the log of changes made to the remaining life cycle data items. Each table gives the configuration management library name for that item, the date and action that was taken, the element(s) affected, the requester, and remarks.

A Support Documentation Change Report that has been logged by the Software Quality Assurance (SQA) representative provides that authority necessary to change the support documentation, including the plans and procedures documents. A Problem Report that has been logged by the SQA representative provides the authority necessary to revise any of the development products (requirements, design, and code). Each reservation of a configuration item should correspond to one change report. The change report should be noted in the remarks section of each table.

C.2 Software Development Standards

LIBRARY: DISK\$HOKIE:[GCS.CMS.DEV_STAND]

DATE	ACTION	ELEMENT	Requester (initials)	Remarks
7/22/93	create element	dev_standards.txt	KJH	in-house Software Development Standards
7/27/93	reserve	dev_standards.txt	KJH	FM1
7/28/93	replace	dev_standards.txt	KJH	finished FM1
8/31/93	reserve	dev_standards.txt	KJH	FM2
9/8/93	replace	dev_standards.txt	KJH	finished FM2
	reserve	dev_standards.txt	KJH	FM3
1/4/94	unreserve	dev_standards.txt	KJH	UNRESERVED -- changed FM3
	reserve	dev_standards.txt	KJH	FM3
1/6/94	replace	dev_standards.txt	KJH	finished FM3
5/11/94	reserve	dev_standards.txt	KJH	FM4
5/12/94	replace	dev_standards.txt	KJH	finished FM4
5/17/94	reserve	dev_standards.txt	KJH	FM5
5/23/94	replace	dev_standards.txt	KJH	finished FM5
	reserve	dev_standards.txt	KJH	FM6
5/24/94	replace	dev_standards.txt	KJH	finished FM6
5/25/94	reserve	dev_standards.txt	KJH	FM7
	replace	dev_standards.txt	KJH	finished FM7
	reserve	dev_standards.txt	KJH	FM8
	replace	dev_standards.txt	KJH	finished FM8
	reserve	dev_standards.txt	KJH	FM9
	replace	dev_standards.txt	KJH	finished FM9

C.3 Verification Cases and Procedures (document)

LIBRARY: DISK\$HOKIE:[GCS.CMS.VER_PROC]

DATE	ACTION	ELEMENT	Requester (initials)	Remarks
12/8/94	create element	procedures.	cquach	Verification Procedures and Cases
	reserve	procedures.	cquach	FM1
12/13/94	replace	procedures.	cquach	finished FM1

C.4 Software Verification Plan

LIBRARY: DISK\$HOKIE:[GCS.CMS.VER_PLAN]

DATE	ACTION	ELEMENT	Requester (initials)	Remarks
7/22/93	create element	verplan.doc	SVK	in-house Software Verification Plan
7/27/93	reserve	verplan.doc	SVK	FM1
7/28/93	replace	verplan.doc	SVK	finished FM1
7/29/93	reserve	verplan.doc	SVK	FM2
	replace	verplan.doc	SVK	finished FM2
8/9/93	reserve	verplan.doc	SVK	FM3
8/23/93	replace	verplan.doc	SVK	finished FM3
9/10/93	reserve	verplan.doc	DBT	FM4
9/22/93	replace	verplan.doc	DBT	finished FM4
12/28/93	reserve	verplan.doc	DBT	FM5
3/16/94	replace	verplan.doc	DBT	finished FM5
3/18/94	reserve	verplan.doc	DBT	FM6
5/3/94	replace	verplan.doc	DBT	finished FM6
5/31/94	reserve	verplan.doc	CQUACH	FM7
8/9/94	replace	verplan.doc	CQUACH	finished FM7
12/7/94	reserve	verplan.doc	CQUACH	FM8
12/8/94	replace	verplan.doc	CQUACH	finished FM8
4/17/95	fetch (kjh)	verplan.doc	kjh	to review
4/19/95	reserve (kjh)	verplan.doc	cq	for SDCR #9
9/13/95	replace (kjh)	verplan.doc	cq	finished SDCR#9

C.5 Software Configuration Management Plan

LIBRARY: DISK\$HOKIE:[GCS.CMS.CM_PLAN]

DATE	ACTION	ELEMENT	Requester (initials)	Remarks
7/22/93	create element	cm_plan.txt	LJS	in-house Software Configuration Management Plan
8/31/93	reserve	cm_plan.txt	LJS	FM1
9/1/93	replace	cm_plan.txt	LJS	finished FM1
5/18/94	reserve	cm_plan.txt	LJS	FM2
	replace	cm_plan.txt	LJS	finished FM2
	reserve	cm_plan.txt	LJS	FM3
5/19/94	replace	cm_plan.txt	LJS	finished FM3
	reserve	cm_plan.txt	LJS	FM4
5/20/94	replace	cm_plan.txt	LJS	finished FM4
12/21/94	reserve	cm_plan.txt	LJS	FM5
12/22/94	replace	cm_plan.txt	LJS	finished FM5
1/25/95	reserve	cm_plan.txt	ljs	FM6
2/27/95	replace	cm_plan.txt	ljs	finished FM 6

C.6 Software Requirements Data

LIBRARY: DISK\$HOKIE:[GCS.CMS.SPEC]

DATE	ACTION	ELEMENT	Requester (initials)	Remarks
5/17/93	create element	spec_2_1.txt	KJH	in-house Software Requirements Data
	reserve	spec_2_1.txt	KJH	transitional requirements phase
	replace	spec_2_1.txt	KJH	finished mods
	reserve	spec_2_1.txt	KJH	completed mods for Spec 2.1
	create element	spec_2_2.txt	KJH	official version 2.2
	replace	spec_2_1.txt	KJH	completed mods for Spec 2.1
	reserve	spec_2_2.txt	KJH	FM 2.2-1, 2, &3
	replace	spec_2_2.txt	KJH	finished FM 2.2-1, 2, &3
	reserve	spec_2_2.txt	KJH	FM 2.2-4
	replace	spec_2_2.txt	KJH	finished FM 2.2-4
	reserve	spec_2_2.txt	KJH	FM 2.2-5
	replace	spec_2_2.txt	KJH	finished FM 2.2-5
	reserve	spec_2_2.txt	KJH	FM 2.2-6, 7, &8
	replace	spec_2_2.txt	KJH	finished FM 2.2-6, 7, &8
	reserve	spec_2_2.txt	KJH	FM 2.2-9
5/24/93	replace	spec_2_2.txt	KJH	finished FM 2.2-9 * (1) virtual memory error
	fetch	spec_2_2.txt		had virtual memory error message - ensuring replacement of mod 2.2-9
5/27/93	reserve	spec_2_2.txt	KJH	FM 2.2-10
6/2/93	replace	spec_2_2.txt	KJH	finished FM 2.2-10
	reserve	spec_2_2.txt	KJH	FM 2.2-11
	replace	spec_2_2.txt	KJH	finished FM 2.2-11
	reserve	spec_2_2.txt	KJH	FM 2.2-12
	replace	spec_2_2.txt	KJH	finished FM 2.2-12
	reserve	spec_2_2.txt	KJH	FM 2.2-13
	replace	spec_2_2.txt	KJH	finished FM 2.2-13
	reserve	spec_2_2.txt	KJH	FM 2.2-14
	replace	spec_2_2.txt	KJH	finished FM 2.2-14
	reserve	spec_2_2.txt	KJH	FM 2.2-15
	replace	spec_2_2.txt	KJH	finished FM 2.2-15
	reserve	spec_2_2.txt	KJH	FM 2.2-16
6/3/93	replace	spec_2_2.txt	KJH	finished FM 2.2-16
	reserve	spec_2_2.txt	KJH	FM 2.2-17
	replace	spec_2_2.txt	KJH	finished FM 2.2-17
	reserve	spec_2_2.txt	KJH	FM 2.2-18
	replace	spec_2_2.txt	KJH	finished FM 2.2-18
	reserve	spec_2_2.txt	KJH	FM 2.2-19
	replace	spec_2_2.txt	KJH	finished FM 2.2-19
	reserve	spec_2_2.txt	KJH	FM 2.2-20
6/4/93	replace	spec_2_2.txt	KJH	finished FM 2.2-20

LIBRARY: DISK\$HOKIE:[GCS.CMS.SPEC]

DATE	ACTION	ELEMENT	Requester (initials)	Remarks
	reserve	spec_2_2.txt	KJH	FM 2.2-21
	replace	spec_2_2.txt	KJH	finished FM 2.2-21
	reserve	spec_2_2.txt	KJH	FM 2.2-22
	replace	spec_2_2.txt	KJH	finished FM 2.2-22
6/4/93	reserve	spec_2_2.txt	KJH	FM 2.2-23
6/7/93	replace	spec_2_2.txt	KJH	finished FM 2.2-23
	reserve	spec_2_2.txt	KJH	FM 2.2-24
	replace	spec_2_2.txt	KJH	finished FM 2.2-24
	reserve	spec_2_2.txt	KJH	FM 2.2-25
	replace	spec_2_2.txt	KJH	finished FM 2.2-25 * (2) checksum error, virtual memory error
	reserve	spec_2_2.txt	KJH	FM 2.2-26
6/9/93	replace	spec_2_2.txt	KJH	finished FM 2.2-26 * (3) virtual memory error
	fetch	spec_2_2.txt		virtual memory error occurred when trying to replace with spec with mod 2.2-26
1/6/94	reserve	spec_2_2.txt	KJH	FM 2.2-27
1/14/94	replace	spec_2_2.txt	KJH	finished FM 2.2-27 * (4) checksum error, virtual memory error
	reserve	spec_2_2.txt	KJH	FM 2.2-28
2/15/94	replace	spec_2_2.txt	KJH	finished FM 2.2-28
	reserve	spec_2_2.txt	BB	FM 2.2-29
3/18/94	replace	spec_2_2.txt	BB	finished FM 2.2-29
	create element	spec_2_3.txt	BB	Spec Version 2.3
5/11/94	reserve	spec_2_3.txt	BB	FM 2.3-1
5/13/94	replace	spec_2_3.txt	BB	finished FM 2.3-1
	reserve	spec_2_3.txt	BB	FM 2.3-2
5/16/94	unreserve	spec_2_3.txt	BB	font problem when replace Spec with FM 2.3-1; need to redo mod
	reserve/gen=1	spec_2_3.txt	BB	FM 2.3-1; font problem with original mod
5/18/94	delete gen	spec_2_3.txt	BB	need to remove so updated mod can be entered in library
	replace	spec_2_3.txt	BB	finished FM 2.3-1
	reserve	spec_2_3.txt	BB	FM 2.3-2
5/19/94	replace	spec_2_3.txt	BB	finished FM 2.3-2
5/25/94	reserve	spec_2_3.txt	BB	FM 2.3-3
6/15/94	replace	spec_2_3.txt	BB	finished FM 2.3-3
8/22/94	reserve	spec_2_3.txt	BB	FM 2.3-4
8/25/94	replace	spec_2_3.txt	BB	finished FM 2.3-4

LIBRARY: DISK\$HOKIE:[GCS.CMS.SPEC]

DATE	ACTION	ELEMENT	Requester (initials)	Remarks
9/13/94	reserve	spec_2_3.txt	BB	FM 2.3-5
9/23/94	replace	spec_2_3.txt	BB	finished FM 2.3-5
11/28/94	reserve	spec_2_3.txt	BB	FM 2.3-6
12/22/94	replace	spec_2_3.txt	BB	finished FM 2.3-6
1/27/95	reserve	spec_2_3.txt	bb	FM 2.3-7
3/15/95	replace	spec_2_3.txt	bb	finished FM 2.3-7

C.7 Design Description for the Mercury Implementation

LIBRARY: DISK\$HOKIE:[GCS.CMS.DES_DESCRIP.MERCURY]

DATE	ACTION	ELEMENT	Requester (initials)	Remarks
6/2/93	create element	mercury_design.	MCL	in-house teamwork design
7/26/93	reserve	mercury_design.	MCL	updating design to most current version of Spec
7/27/93	replace	mercury_design.	MCL	finished mods
	create element	gcs_design.ps	MCL	Design Description Document
12/6/93	create element	design.overview_intro	ADB	Mercury Design Description Overview (introduction)
		design.overview_preface	ADB	Mercury Design Description Overview (preface & table of contents)
		design.overview_labels	ADB	Mercury Design Description Overview (section labels)
12/10/93	create element	design.teamwork	ADB	teamwork model (with mods thru 2.2-26)
12/21/93	reserve	design.teamwork	ADB	PR#1
1/18/94	replace	design.teamwork	ADB	finished PR#1
1/19/94	reserve	design.teamwork	ADB	PR#2
1/28/94	replace	design.teamwork	ADB	finished PR#2
1/31/94	reserve	design.teamwork	ADB	PR#3
2/15/94	replace	design.teamwork	ADB	finished PR#3
2/24/94	reserve	design.teamwork	ADB	PR#4
3/14/94	replace	design.teamwork	ADB	finished PR#4
3/21/94	reserve	design.teamwork	ADB	PR#5
3/25/94	replace	design.teamwork	ADB	finished PR#5
3/29/94	reserve	design.teamwork	ADB	PR#6
3/31/94	replace	design.teamwork	ADB	finished PR#6
4/5/94	reserve	design.teamwork	ADB	PR#7
4/6/94	unreserve	design.teamwork	ADB	UNRESERVE - may have been a problem with reservation
	reserve	design.teamwork	ADB	PR#7 (again)

LIBRARY: DISK\$HOKIE:[GCS.CMS.DES_DESCRIP.MERCURY]

DATE	ACTION	ELEMENT	Requester (initials)	Remarks
4/20/94	replace	design.teamwork	ADB	finished PR#7
4/21/94	reserve	design.teamwork	ADB	PR#8
4/25/94	replace	design.teamwork	ADB	finished PR#8
	reserve	design.teamwork	ADB	PR#9
4/29/94	replace	design.teamwork	ADB	finished PR#9
5/3/94	reserve	design.teamwork	ADB	PR#10
5/9/94	replace	design.teamwork	ADB	finished PR#10
	reserve	design.teamwork	ADB	PR#11
5/11/94	replace	design.teamwork	ADB	finished PR#11
	reserve	design.teamwork	ADB	PR#11 * problem when FTPed design - need to replace with good file
5/12/94	replace	design.teamwork	ADB	finished PR#11
5/13/94	reserve	design.teamwork	ADB	PR#12
5/16/94	reserve	design.overview_intro	ADB	PR#12
5/18/94	replace	design.teamwork	ADB	finished PR#12
		design.overview_intro		
5/20/94	reserve	design.teamwork	ADB	PR#13
5/31/94	replace	design.teamwork	ADB	finished PR#13
	reserve	design.teamwork	ADB	PR#14
6/1/94	replace	design.teamwork	ADB	finished PR#14
6/20/94	reserve	design.teamwork	ADB	PR#15
6/23/94	replace	design.teamwork	ADB	finished PR#15
7/1/94	reserve	design.teamwork	ADB	PR#16
7/7/94	replace	design.teamwork	ADB	finished PR#16
	reserve	design.teamwork	ADB	PR#17
7/20/94	replace	design.teamwork	ADB	finished PR#17
	reserve	design.teamwork	ADB	PR#18
7/27/94	replace	design.teamwork	ADB	finished PR#18
	reserve	design.teamwork	ADB	PR#19
8/3/94	replace	design.teamwork	ADB	finished PR#19
	reserve	design.teamwork	ADB	PR#20
8/15/94	replace	design.teamwork	ADB	finished PR#20
	reserve	design.teamwork	ADB	PR#21
8/18/94	replace	design.teamwork	ADB	finished PR#21
	reserve	design.teamwork	ADB	PR#22
		design.overview_intro	ADB	
		design.overview_preface	ADB	
		design.overview_labels	ADB	
8/24/94	replace	design.teamwork	ADB	finished PR#22
		design.overview_intro	ADB	
		design.overview_preface	ADB	
		design.overview_labels	ADB	
8/25/94	reserve	design.teamwork	ADB	PR#23
		design.overview_intro	ADB	
		design.overview_preface	ADB	
		design.overview_labels	ADB	
8/31/94	replace	design.teamwork	ADB	finished PR#23
		design.overview_intro	ADB	

LIBRARY: DISK\$HOKIE:[GCS.CMS.DES_DESCRIP.MERCURY]

DATE	ACTION	ELEMENT	Requester (initials)	Remarks
		design.overview_preface	ADB	
		design.overview_labels	ADB	
9/16/94	reserve	design.teamwork	ADB	PR#24
9/21/94	replace	design.teamwork	ADB	finished PR#24
10/20/94	reserve	design.teamwork	ADB	PR#25
12/5/94	replace	design.teamwork	ADB	finished PR#25
12/7/94	reserve	design.teamwork	ADB	PR#26
12/14/94	replace	design.teamwork	ADB	finished PR#26
12/22/94	reserve	design.teamwork	ADB	PR#27
1/3/95	replace	design.teamwork	ADB	finished PR#27
2/8/95	reserve	design.teamwork	adb	PR#28
2/14/95	replace	design.teamwork	adb	finished PR#28
3/21/95	reserve	design.teamwork	adb	PR #30
3/24/95	replace	design.teamwork	adb	finished PR #30
4/28/95	reserve	design.teamwork	adb	PR#31
5/1/95	reserve	design.overview_labels	adb	PR#31
5/5/95	replace	design.overview_labels	adb	finished PR#31
		design.teamwork		

C.8 Design Description for the Pluto Implementation

LIBRARY: DISK\$HOKIE:[GCS.CMS.DES_DESCRIP.PLUTO]

DATE	ACTION	ELEMENT	Requester (initials)	Remarks
8/31/93	create element	design.teamwork	PSC	in-house teamwork model from RTI version
	reserve	design.teamwork	PSC	updating teamwork model to Spec version 2.2
	replace	design.teamwork	PSC	finished mod
	create element	design.overview	PSC	Pluto Design Description Overview
11/1/93	reserve	design.teamwork	PSC	PR#1
1/18/94	replace	design.teamwork	PSC	finished PR#1
1/25/94	reserve	design.teamwork	PSC	PR#2
2/15/94	replace	design.teamwork	PSC	finished PR#2
4/14/94	reserve	design.teamwork	RKA	PR#3
4/20/94	replace	design.teamwork	RKA	finished PR#3
	reserve	design.teamwork	RKA	PR#4
5/2/94	replace	design.teamwork	RKA	finished PR#4
	reserve	design.teamwork	RKA	PR#5
	replace	design.teamwork	RKA	finished PR#5
	reserve	design.teamwork	RKA	PR#6

LIBRARY: DISK\$HOKIE:[GCS.CMS.DES DESCRIP.PLUTO]

DATE	ACTION	ELEMENT	Requester (initials)	Remarks
5/5/94	replace	design.teamwork	RKA	finished PR#6
	reserve	design.teamwork	RKA	PR#7
5/9/94	replace	design.teamwork	RKA	finished PR#7
	reserve	design.teamwork	RKA	PR#8
5/11/94	replace	design.teamwork	RKA	finished PR#8 *checksum error, insufficient virtual memory, error replacing
	reserve	design.teamwork	RKA	PR#9 *checksum error, bad block address
	unreserve	design.teamwork	RKA	checksum error when reserving
	reserve	design.teamwork	RKA	PR#9
	replace	design.teamwork	RKA	finished PR#9
	reserve	design.teamwork	RKA	PR#10
6/2/94	replace	design.teamwork	RKA	finished PR#10
	reserve	design.teamwork	RKA	PR#11
6/9/94	replace	design.teamwork	RKA	finished PR#11 *checksum error, insufficient virtual memory, error replacing
	reserve	design.teamwork	RKA	PR#12
6/21/94	replace	design.teamwork	RKA	finished PR#12 *checksum error, insufficient virtual memory, error replacing
	reserve	design.teamwork	RKA	PR#13 *bad block address
	unreserve	design.teamwork	RKA	bad block address (0 blocks reserved)
	reserve	design.teamwork	RKA	PR#13
6/28/94	replace	design.teamwork	RKA	finished PR#13 *checksum error, insufficient virtual memory, error replacing
	reserve	design.teamwork	RKA	PR#14 *bad block address
	unreserve	design.teamwork	RKA	bad block address (0 blocks reserved)
	reserve	design.teamwork	RKA	PR#14 *bad block address
	unreserve	design.teamwork	RKA	unreserve - bad block address
	delete gen=15	design.teamwork	RKA	corrupt file
	reserve	design.teamwork	RKA	PR#13 - will replace file with uncorrupted file
	replace	design.teamwork	RKA	finished PR#13 *checksum error, insufficient virtual memory, error replacing
	reserve	design.teamwork	RKA	PR#14 *bad block address
	unreserve	design.teamwork	RKA	unreserve - bad block address
	reserve	design.teamwork	RKA	PR#14 *bad block address
6/29/94	replace	design.teamwork	RKA	finished PR#14
7/20/94	reserve	design.teamwork	RKA	PR#15
	unreserve	design.teamwork	RKA	UNRESERVE - wrong model replaced

LIBRARY: DISK\$HOKIE:[GCS.CMS.DES DESCRIP.PLUTO]

DATE	ACTION	ELEMENT	Requester (initials)	Remarks
	delete gen=16	design.teamwork	RKA	wrong model replaced
7/21/94	reserve	design.teamwork	RKA	PR#14 (again)
	replace	design.teamwork	RKA	finished PR#14
	reserve	design.teamwork	RKA	PR#15
	replace	design.teamwork	RKA	finished PR#15
7/21/94	reserve	design.teamwork	RKA	PR#16
7/22/94	replace	design.teamwork	RKA	finished PR#16
	reserve	design.teamwork	RKA	PR#17
7/29/94	remark			due to power outage this entire library had to be backed up; some of the create dates changed to today
	replace	design.teamwork	RKA	finished PR#17
	reserve	design.teamwork	RKA	PR#18
8/2/94	replace	design.teamwork	RKA	finished PR#18
8/11/94	reserve	design.teamwork	RKA	PR#19
		design.overview	RKA	PR#19
8/26/94	replace	design.overview	RKA	finished PR#19 - converted from WordPerfect to Microsoft Word file
		design.teamwork	RKA	finished PR#19
9/16/94	reserve	design.teamwork	RKA	PR#20
	replace	design.teamwork	RKA	finished PR#20
11/18/94	reserve	design.teamwork	PEM	PR#21
		design.overview	PEM	PR#21
11/23/94	replace	design.overview	PEM	finished PR#21
		design.teamwork	PEM	finished PR#21
11/28/94	reserve	design.teamwork	PEM	PR#22
11/30/94	replace	design.teamwork	PEM	finished PR#22
3/16/95	reserve	design.teamwork	pem	PR#27
3/21/95	replace	design.teamwork	pem	finished PR #27

C.9 Source Code for the Mercury Implementation

LIBRARY: DISK\$HOKIE:[GCS.CMS.SOURCE_CODE.MERCURY]

DATE	ACTION	ELEMENT	Requester (initials)	Remarks
9/23/94	create element	*.for	ADB	create Mercury source code files
		*.inc	ADB	create Mercury include files
		*.txt	ADB	create file for instructions to complies Mercury source code
10/20/94	reserve	*.for	ADB	PR#25
		*.inc	ADB	PR#25
12/5/94	replace	*.for	ADB	finished PR#25
		*.inc	ADB	finished PR#25
12/7/94	reserve	*.for	ADB	PR#26
		*.inc	ADB	PR#26
12/14/94	replace	*.for	ADB	finished PR#26
		*.inc	ADB	finished PR#26
	fetch	*.*	DBT	testing code
12/22/94	reserve	cp.for	ADB	PR#27
12/29/94	replace (kjh)	cp.for	ADB	finished PR#27
	fetch (kjh)	cp.for	DBT	for Mercury testing
2/8/95	reserve	gp.for	ADB	PR#28
2/14/95	replace	gp.for	adb	finished PR#28
	fetch	gp.for	dbt	Mercury testing
3/8/95	fetch (kjh)	reclp.for	kjh	to aid in review of structural test cases
3/21/95	reserve	asp.for	adb	PR #30
		gp.for		
3/24/95	replace	asp.for	adb	finished PR #30
		gp.for		
	fetch	asp.for	dbt	for testing of code
		gp.for		
7/20/95	fetch (kjh)	*.for	kjh	to count number of source lines
		*.inc		

C.10 Source Code for the Pluto Implementation

LIBRARY: DISK\$HOKIE:[GCS.CMS.SOURCE_CODE.PLUTO]

DATE	ACTION	ELEMENT	Requester (initials)	Remarks
9/26/94	create element	*.*	RKA	create Pluto source code files
11/23/94	reserve	*.for	PEM	PR#22
11/28/94	unreserve	*.for	PEM	wrong element requested -- wanted design
11/30/94	reserve	*.for	PEM	PR#23
12/5/94	replace	*.for	PEM	finished PR#23
12/21/94	fetch	*.for	cquach	testing Pluto code
1/10/95	reserve	*.for	pem	PR#24
1/13/95	replace	*.for	pem	finished PR#24
	reserve	cp.for	pem	PR#25
	fetch	arsp.for	cquach	Pluto testing
		constants.for		
		gp.for		
		tdlrsp.for		
		tsp.for		
	replace	cp.for	pem	finished PR#25
1/17/95	fetch	cp.for	cquach	testing Pluto code
1/19/95	delete gen=4	cp.for		wrong version of element replaced
	reserve	cp.for	pem	PR#25
	replace	cp.for	pem	finished PR#25 -- replacing with correct version of element
	fetch	cp.for	cquach	for Pluto testing
2/14/95	reserve	clpsf.for	pem	PR#26
		pluto.for		
2/15/95	replace	clpsf.for	pem	finished PR#26
		pluto.for		
3/6/95	fetch	pluto.for	cq	trajectory testing
		clpsf.for		
3/15/95	reserve	asp.for	pem	PR #27
		gp.for		
3/21/95	replace	asp.for	pem	finished PR #27
		gp.for		
4/6/95	fetch (kjh)	*.for	cq	for functional unit testing
	reserve (kjh)	*.for	cq	PR#28
	replace (kjh)	*.for	cq	finished PR#28
	fetch (kjh)	*.for	cq	for functional unit testing

C.11 Test Cases

including models, drivers, and expected results

LIBRARY: DISK\$HOKIE:[GCS.CMS.VER_CASES]

DATE	ACTION	NAME	Requester (initials)	Remarks
8/4/94	create group	functional		group containing functional unit test cases
		subframe		group containing subframe test cases
		frame		group containing frame test cases
		normal		subgroup of functional group containing normal range test cases
		robustness		subgroup of functional group containing robustness test cases
		structural		subgroup of functional group for structural test cases (implementation specific)
		models		subgroup of functional group containing math models
		drivers		subgroup of functional group containing drivers
	insert group	drivers -> functional		subgroup of functional unit group
		models -> functional		subgroup of functional unit group
		normal -> functional		subgroup of functional unit group
		robustness -> functional		subgroup of functional unit group
		structural -> functional		subgroup of functional unit group
	create group	pluto		subgroup of structural group for Pluto test cases
		mercury		subgroup of structural group for Mercury test cases
	insert group	mercury -> structural		subgroup of structural group
		pluto -> structural		subgroup of structural group
	create element	aeclp_nr_001.ex, .tc	DBT	AECLP functional unit test cases NR: 001 ->012; RO : 013 -> 036
	insert element	*nr*.* -> normal		normal range test case for AECLP functional unit
		ro.* ->robustness		robustness test case for AECLP functional unit
8/15/94	create element	aeclp_nr_039.ex, .tc	DBT	AECLP functional unit test case NR: 039 -> 047; RO: 037,038

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DATE	ACTION	NAME	Requester (initials)	Remarks
		crclp_nr_001.ex, .tc		CRCP functional unit test case NR: 001 -> 006; RO: 007 -> 010
	insert element	*nr*. * -> normal		normal range test case for AECLP/CRCP functional unit
		ro. * -> robustness		robustness test case for AECLP/CRCP functional unit
8/29/94	reserve	aeclp*.ex	DBT	FM 1
		crclp*.ex		FM 2
	replace	aeclp*.ex	DBT	finished FM 1 * error replacing aeclp_nr_039.ex thru aeclp_nr_47.ex
		crclp*.ex		finished FM 2
	unreserve	aeclp_nr_039 -> 047.ex	dbt	should have been robustness test cases
8/30/94	remove element	aeclp_nr_039 -> 047.ex, .tc from normal	DBT	should have been robustness test case
	delete element	aeclp_nr_039 -> 047.ex,.tc	DBT	should have been robustness test case
	create element	aeclp_ro_039 -> 053.ex, .tc	DBT	AECLP functional unit test case
	insert element	aeclp*ro*. * -> robustness		robustness test case for AECLP functional unit
8/31/94	create element	r*. *	DBT	RECLP functional unit test case NR: 1-59, 64-68; RO: 60 - 63
	insert element	r*nr*. * -> normal		normal range test case for RECLP functional unit
		r*ro*. * -> robustness		robustness test case for RECLP functional unit
9/6/94	create element	gp*. *	DBT	GP functional unit test cases NR:1 - 8, 53, 102 - 106; RO: 9 - 52, 54 - 101, 107 - 114
	insert element	gp_nr*. * -> normal		normal range test case for GP functional unit
		gp_ro*. * -> robustness		robustness test case for GP functional unit
9/12/94	reserve	gp*. *	DBT	FM 3
9/13/94	create element	aeclp*. *	DBT	functional unit test cases NR: 54, 55; RO: 56,57
	insert element	a*nr*. * -> normal		normal range test case for AECLP functional unit
		a*ro*. * -> robustness		robustness test case for AECLP functional unit
9/13/94	replace	gp*. *	DBT	finished FM 3
12/2/94	reserve	gp*. *	DBT	FM 4
		aeclp*. *		FM 5

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DATE	ACTION	NAME	Requester (initials)	Remarks
		reclp*.*		FM 6
		crclp*.*		FM 7
	replace	gp*.*	DBT	finished FM 4
		aeclp*.*		finished FM 5
	reserve	gp*.*	DBT	FM 4 -- replace with wrong file
		aeclp*.*		FM 5 -- replace with wrong file
	replace	gp*.*	DBT	finished FM 4
		aeclp*.*		finished FM 5
		reclp*.*		finished FM 6
		crclp*.*		finished FM 7
12/5/94	create element	gpsf*.*	dbt	GP subframe test case
		clp*.*	dbt	CLP subframe test case
	insert element	gpsf*.* -> subframe		subframe test case for GP
		clp*.* -> subframe		subframe test case for CLP
12/8/94	create element	gp_ro*.*	DBT	GP functional unit test case
		cp_nr*.*	CQUACH	CP functional unit test case
		*.m		mathematica model
		*.m	DBT	mathematica model
		arsp*.*	CQUACH	ARSP functional unit test case
		asp*.*		ASP functional unit test case
		gsp*.*		GSP functional unit test case
		tdlrsp*.*		TDLRSP functional unit test case
		tdsp*.*		TDSP functional unit test case
		tsp*.*		TSP functional unit test case
		frame*.*		frame test case
		sp*.*		subframe test case
		common.inc		models
		cp.for		mathematica model
		*.inc		mathematica model
	insert element	*_nr*.* -> normal		normal range test cases
		_ro.*		robustness test cases
	remove element	*_imm*.* -> subframe		element should not have been created
	delete element	*_imm*.*		element should not have been created
	insert element	sp*.* -> subframe		subframe test case
		frame*.* -> frame		frame test case
		cp.for -> models		mathematica model
		*.inc -> models		mathematica model
		*.m -> models		mathematica model
12/14/94	fetch	aeclp_*_*.*	DBT	testing Mercury code

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DATE	ACTION	NAME	Requester (initials)	Remarks
		reclp_*.*		
		gp_*.*		
		crcp_*.*		
12/16/94	fetch	clp_0*.*	DBT	testing Mercury code
		gpsf_0*.*		
		sp_0*.*		
		asp_*.*		
		arsp_*.*		
		tdlrsp_*.*		
		tdsp_*.*		
		gsp_*.*		
		tsp_*.*		
12/19/94	fetch	cp_*.*	DBT	testing Mercury code
	create element	m_*.*	DBT	Mercury drivers
		compar*.*		drivers
12/19/94	create element	ex_cp.for	DBT	drivers
		read_*.*		
		run_*.*		
	insert element	m_*. * -> drivers		drivers for Mercury
		compar*.* -> drivers		drivers
		ex_cp.for -> drivers		
		read_*. * . drivers		
		run_*. * -> drivers		
12/21/94	fetch	aeclp_*.*	cquach	testing Pluto code
		arsp_*.*		
		asp_*.*		
		clp_*.*		
		cp_*.*		
		crcp_*.*		
		frame_*.*		
		gp_*.*		
		gpsf_*.*		
		gsp_*.*		
		reclp_*.*		
		sp_*.*		
		tdlrsp_*.*		
		tdsp_*.*		
		tsp_*.*		
12/22/94	reserve	cp.for	cquach	FM8
		cp*.*		
12/28/94	replace (kjh)	cp.for	cquach	finished FM8
		cp_*.*		

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DATE	ACTION	NAME	Requester (initials)	Remarks
	fetch (kjh)	cp_*.*	dbt	for Mercury testing (new cp test cases)
		cp.for	cquach	for Pluto testing
		cp_*.*		
	reserve (kjh)	asp.m	cquach	FM9
		asp_*.*		
12/29/94	replace (kjh)	asp_*.*	cquach	finished FM9
	fetch (kjh)	asp_*.*	cquach	for Pluto testing
	create group (kjh)	pluto_drivers		temp driver storage for Pluto
1/3/95	create element	p_*.*	cquach	drivers for Pluto
	insert element	p_*.*.> drivers		Pluto drivers
	fetch	p_*.*	cquach	testing Pluto code
1/4/95	fetch (cquach)	gp_nr_001.ex		for Pluto testing
		gp_nr_001.tc		
	unreserve	asp.m		reserved by mistake
1/11/95	reserve	cp.for	cquach	FM10
		cp_*.*		
1/12/95	replace	cp*.*	cquach	finished FM10
	fetch	cp_*.*	cquach	for Pluto testing
		cp_*.ex	dbt	Mercury testing
1/30/95	fetch	*.m	cquach	Pluto testing
2/3/95	fetch	G: frame	dbt	Mercury testing
		G: subframe		
2/7/95	reserve	p_ex_cp.for	cquach	FM 11
2/8/95	reserve	clp_011.*	cquach	FM 12
		gpsf_*.*		
2/10/95	unreserve	p_ex_cp.for	cquach	should not be implementation specific
	reserve	ex_cp.for		FM 11
	replace	ex_cp.for		finished FM 11
2/13/95	replace	clp_011.*	cquach	finished FM 12
		gpsf_*.*		
2/13/95	fetch	ex_cp.for	dbt	Mercury testing
		clp_011.tc		
		gpsf_*.*		
	reserve	m_clp_driver.com	dbt	FM 13
		m_gpsf_driver.com		
		m_lnkframe.com		
		m_lnkgpsf.com		
		m_lnksp.com		
		m_sp_driver.com		
2/14/95	fetch	clp_011.ex	dbt	Mercury testing

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DATE	ACTION	NAME	Requester (initials)	Remarks
		sp_001.*	cquach	Pluto testing
		gpsf_*.*		
		clp_*.*		
	create group	trajectory		group containing trajectory test cases
	create element	*traj*.*	cquach	trajectory test cases
		pluto.com		
		run_mc.com		
	insert element	*traj* -> trajectory		trajectory test cases
		pluto.com -> trajectory		
		run_mc.com -> trajectory		
	replace	m_clp_driver.com	dbt	finished FM 13
		m_gpsf_driver.com		
		m_lnkframe.com		
		m_lnkgpsf.com		
		m_lnksp.com		
		m_sp_driver.com		
2/16/95	reserve	frame_*.*	dbt	FM 14
		p_test_frame.for	cquach	
	replace	frame_*.*	cquach	finished FM 14
		p_test_frame.for		
	fetch	frame_*.*	dbt	Mercury testing
	create element	m_test_frame.for	dbt	driver for Mercury
	insert element	m_test_frame.for -> drivers		Mercury driver
2/21/95	create element	asp_pst_*.*	cquach	structural test cases
		tdlrsp_pst_*.*		
		*_pst.com		test drivers
	insert element	*pst.com -> drivers		test case drivers
2/22/95	create element	reclp_pst_*.*	cquach	Pluto structural test cases
	insert element	*_pst_*. * -> Pluto		Pluto structural test cases
	create element	m_*_st_0%%.*	dbt	Mercury structural test cases
		m_*_st.*		Mercury Mathematica models
		m*struct_reclp.*		
	insert element	m_*_st_0%%.* -> Mercury		Mercury structural test cases
	remove element	m_*_st_0%%.m		placed in wrong group by mistake
	insert element	m_*_st.* -> Mercury		Mercury Mathematica models
		m_*st*.m -> Mercury		
		m*struct_reclp.* -> Mercury		
2/23/95	reserve	gp.m	cquach	FM15

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DATE	ACTION	NAME	Requester (initials)	Remarks
		gp_*.*		
		gpsf_*.*		
		frame_*.*		
2/24/95	replace	gp.m	cquach	finished FM15
		gp_*.*		
2/24/95	replace	gpsf_*.*	cquach	finished FM15
		frame_*.*		
	fetch	gp.m	cquach	retesting
		gp_*.*		
		gpsf_*.*		
		frame_*.*		
	reserve	m_gp_st*.*	dbt	FM 16
	create element	*aeclp*.*	dbt	Mathematica models
		crclp.*		
		gp.*		
		reclp.*		
	reserve	m_run_gp_st*.*	dbt	FM 16
	replace	m_gp_st*.*	dbt	finished FM 16
		m_run_gp_st*.*		
	create element	input.	dbt	Mathematica model
		namelist1.		
		namelis_ex.		
	insert element	aeclp_tc.* -> models		Mathematica models
		crclp_tc.* -> models		
		gp_tc.* -> models		
		reclp_tc.* -> models		
		run_aeclp.%%,%%-%%,%%-%% -> models		
		run_crclp.%% -> models		
		run_gp.%%,%%-%%,%%-%% -> models		
		run_reclp.%%,%%-%%,%%-%% -> models		
	create element	m_st_driver.com	dbt	Mercury driver
	insert element	m_st_driver.com -> drivers		Mercury driver
	reserve	m_run_aeclp_st.*	dbt	FM 17
		m_run_reclp_st.*		
	fetch	m_aeclp_st*.*	dbt	Mercury testing
		m_arsp_st*.*		
		m_asp_st*.%%		
		m_gp_st*.*		
		m_reclp_st*.*		
		m_tdlrsp_st*.*		

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DATE	ACTION	NAME	Requester (initials)	Remarks
		m_tsp_st *.*		
		gp_nr *.*		
		gp_ro *.*		
		gpsf *.*		
		frame *.*		
	insert element	input. -> models		Mathematica model
		namelist1. -> models		
		namelist_ex. -> models		
	replace	m_run_aeclp_st.*	dbt	finished FM 17
		m_run_reclp_st.*		
	create element	gp_pst *.*	cquach	Pluto structural test cases
		aeclp_pst *.*		
		run_gp_pst.com		Pluto test case drivers
		run_aeclp_pst.com		
	insert element	*_pst *.* -> pluto		Pluto structural test cases
		*pst.com -> drivers		Pluto test case drivers
2/27/95	reserve	gp *.*.tc	dbt	FM 18
	unreserve	*pst *.*		not needed
2/27/95	reserve	gp_nr *.*.ex	dbt	FM 18
		gp_ro *.*.ex		
		gpsf *.*		
		m_gp_st *.*		
		namelist1.		
		namelist_ex.		
	fetch (kjh)	traj_td *.*	cq	for evaluation of test cases expected results
2/28/95	fetch (kjh)	gp_nr *.*	cq	to rerun GP functional unit test cases (SDCR 18)
	replace (kjh)	gp_nr *.*.ex	dbt	for SDCR 18
		gp_ro *.*.ex		
		gpsf *.*		
		m_gp_st *.*		
		namelist_ex.		
		namelist1.		
3/1/95	fetch (kjh)	gp_nr *.*	cq	to rerun GP functional unit test cases (SDCR 18)
		gp_ro *.*		
		gpsf *.*	cq	to run subframe test cases (SDCR 18)
		frame *.*	cq	to run frame test cases (SDCR 18)
		gp.m	cq	copy of revised gp model
	reserve (kjh)	m_gp_st *.*	dbt	SDCR 19
	replace (kjh)	m_gp_st *.*	dbt	for SDCR 19

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DATE	ACTION	NAME	Requester (initials)	Remarks
	fetch (kjh)	gp_*.*	dbt	to rerun GP functional unit test cases (SDCR 18)
		gpsf_*.*	dbt	to run subframe test cases
		m_gp_st*.*	dbt	for GP structural tests
	unreserve (kjh)	m_gp_st.*		wrong file reserved -- should have been test case files, not models
3/2/95	reserve (kjh)	gpsf_*.*	dbt	SDCR 20
	replace (kjh)	gpsf_*.*	dbt	for SDCR 20
	create element (kjh)	run_gpsf.*	dbt	Mathematica models for GP subframe
	fetch (kjh)	gpsf_*.*	dbt	to rerun GP subframe test cases (SDCR 20)
		sp_001.*	cq	for subframe testing
		gpsf_*.*	cq	for GP subframe testing
		clp_*.*	cq	for Control Law Processing subframe testing
		frame_*.*	cq	for frame testing
		frame_*.*	dbt	for frame testing
		traj_atm_*.*	dbt	for trajectory testing of Mercury
		traj_td_*.*		
		traj.com		
		run_traj.com		
3/3/95	reserve (kjh)	gp_pst_*.*	cq	SDCR 21
3/6/95	create element (kjh)	*.m	cq	models used to generate Pluto structural test cases
		m_*.com	dbt	file for running Mercury trajectory test cases
	replace (kjh)	gp_pst_*.*	cq	for SDCR 21
	fetch	traj.com	cq	trajectory testing
		run_traj.com	cq	trajectory testing
		traj_atm_*.*		
		traj_td_*.*		
3/7/95	fetch	m_aeclp_st*.*	dbt	structural testing of Mercury (**wrong remark entered in CMS**)
		m_gp_st*.*		
		m_reclp_st*.*		
		m_asp_st*.*		
	reserve	m_st_driver.com	dbt	SDCR 22
	replace	m_st_driver.com	dbt	finished SDCR 22
	fetch	m_st_driver.com	dbt	structural testing of Mercury
3/10/95	reserve	m_tdlrsp_st*.*	dbt	SDCR 23
	replace	m_tdlrsp_st*.*	dbt	finished SDCR 23

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DATE	ACTION	NAME	Requester (initials)	Remarks
3/10/95	create element	*run*.*	dbt	Mathematica drivers for Mercury
		st.ex	dbt	structural expected values for Mercury
		st.tc	dbt	structural test cases for Mercury
	insert element	*run*.* -> drivers	dbt	Mathematica drivers for Mercury
		m_gp_st.* -> drivers		
	remove element	m_gp_st.* -> drivers		placed in wrong group
	create element	m_tdlrsp_st_*.m	dbt	Mathematica models for Mercury
	insert element	m_*.m -> models		Mathematica models for Mercury
	remove element	*run*.* -> drivers		placed in wrong group
	insert element	m_gp_st_%%%%%%%% -> Mercury		Mercury structural test cases and expected values
		m_run_*. * -> models		Mathematica models for Mercury
3/13/95	insert element	*.m -> models		Mathematica models
		run_gpsf.%% -> models	dbt	Mathematica models
		m*traj.com -> trajectory	dbt	trajectory test cases
3/14/95	create element	m_cp_st_*. *	dbt	Mercury structural test cases and expected values
	insert element	m_cp_st_*. * -> Mercury		Mercury structural test cases and expected values
3/15/95	reserve	gp.m	cq	SDCR #24
		asp.m		
		frame.m		
		asp_nr_*. *		
		asp_ro_*. *		
		gp_nr_*. *		
		gp_ro_*. *		
		sp_*. *		
		gpsf_*. *		
		frame_*. *		
		m_asp_st_*. *	dbt	SDCR #25
		m_gp_st_*. *		
		reclp_nr_068.*	dbt	SDCR 27
3/16/95	create element	m_reclp_st_*. *	dbt	Mercury structural test cases
		m_reclp_st.*	dbt	Mercury Mathematica driver
		m_run_reclp_st.*		
	insert element	m_reclp_st_*. * -> Mercury		Mercury structural test cases

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DATE	ACTION	NAME	Requester (initials)	Remarks
		m_reclp_st.* -> drivers		Mercury Mathematica driver
		m_run_reclp_st.* -> drivers		
	remove element	m_reclp_st.* -> drivers		placed in wrong group
		m_run_reclp_st.* -> drivers		
	replace	reclp_nr_068.*	dbt	finished SDCR 27
3/23/95	replace	gp.m	cq	finished SDCR #24
		asp.m		
		frame.m		
		asp_nr_*.*		
		asp_ro_*.*		
		gp_nr_*.*		
		gp_ro_*.*		
		sp_*.*		
		gpsf_*.*		
		frame_*.*		
3/24/95	fetch	gp_nr_*.*	dbt	Mercury trajectory testing
		gp_ro_*.*		
		asp_nr_*.*		
3/24/95	fetch	asp_ro_*.*	dbt	Mercury trajectory testing
		gpsf_*.*		
		sp_*.*		
		frame_*.*		
		traj_atm_*.*		
		traj_td_*.*		
3/27/95	create element	gp_ro_117.*	dbt	GP functional unit test case
	insert element	gp_ro_117.* -> robustness		robustness functional unit test cases
	fetch	gp_ro_117.*		for Mercury testing
3/28/95	create element	m_asp_st_*.tc	dbt	Mercury structural test cases
		m_asp_st_*.ex		
	insert element	m_asp_st_*. * -> Mercury		Mercury structural test cases
	create element	*.seed	cq	trajectory test expected values
	insert element	*.seed -> trajectory		trajectory test expected values
	fetch	m_aeclp*.ex, .tc	dbt	Mercury structural testing
		m_asp*.ex, .tc		
		m_cp*.ex, .tc		
		m_gp*.ex, .tc		
		m_reclp*.ex, .tc		
		m_tdlrsp*.ex, .tc		
		*.seed	dbt	Mercury trajectory testing

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DATE	ACTION	NAME	Requester (initials)	Remarks
x4/3/95	replace (kjh)	m_asp_st_*.ex, .tc	dbt	finished SDCR #25
		m_gp_st_*.ex, .tc		
	reserve (kjh)	run_traj.com	cq	SDCR #31
		tdlrsp.m	cq	SDCR #28
		tdlrsp_nr_*.*	cq	
		sp_001.*		
		frame_*.ex, .tc		
	replace (kjh)	run_traj.com	cq	for SDCR #31
	reserve (kjh)	tdlrsp_pst_*.ex, .tc	cq	SDCR #30
	replace (kjh)	m_asp_st_*.m	dbt	finished SDCR #25
	create (kjh)	m_asp_st_*.m	dbt	Mercury structural test case -- models
	reserve (kjh)	m_tdlrsp_st_*.*	dbt	SDCR #29
4/5/95	unreserve (kjh)	tdlrsp_pst_*.ex, .tc	cq	no modifications were needed (see SDCR #30)
	reserve (kjh)	asp_pst_*.tc, .ex	cq	for SDCR #26
	fetch (kjh)	asp.m	cq	for SDCR #26 -- to regenerate test cases
	reserve (kjh)	gp_pst_*.tc, .ex	cq	for SDCR #26
	fetch (kjh)	gp.m	cq	for SDCR #26 -- for regeneration of test cases
		asp.m	dbt	to verify structural test cases
		gp.m		
		aeclp.m		
		reclp.m		
		cp.for		
		m_asp_st_*.*		
		m_aeclp_st*.*		
		m_gp_st*.*		
		m_reclp_st*.*		
		m_cp_st*.*		
	reserve (kjh)	tdlrsp_ro_*.tc, .ex	cq	for SDCR #28
	replace (kjh)	tdlrsp.m	cq	for SDCR #28
		tdlrsp_nr_*.*		
		tdlrsp_ro_*.*		
		sp_001.*		
		frame_*.*		
	fetch (kjh)	tdlrsp.m	dbt	to verify structural test cases
4/5/95	fetch (kjh)	m_tdlrsp_st_*.*	dbt	to verify structural test cases
	replace (kjh)	gp_pst_*.tc, .ex	cq	for SDCR #26
		asp_pst_*.tc, .ex		
	reserve (kjh)	gp_pst_018.*	cq	for SDCR #26
	replace (kjh)	gp_pst_018.*	cq	for SDCR #26
4/6/95	replace (kjh)	m_tdlrsp_st_*.*	dbt	for SDCR #29

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DATE	ACTION	NAME	Requester (initials)	Remarks
	unreserve (kjh)	gp_nr_053.ex1	kjh	nonexistent test case
		tdlrsp_nr_006.*		
	remove element (kjh)	tdlrsp_nr_006.* from normal	kjh	not a valid test case
		gp_nr_053.ex1 from normal		
	fetch (kjh)	aeclp_nr_*.*	dbt	for functional unit testing
		aeclp_ro_*.*		
		arsp_nr_*.*		
		arsp_ro_*.*		
		asp_nr_*.*		
		asp_ro_*.*		
		cp_nr_*.*		
		crclp_nr_*.*		
		crclp_ro_*.*		
		gp_nr_*.*		
		gp_ro_*.*		
		gsp_nr_*.*		
		gsp_ro_*.*		
		reclp_nr_*.*		
		reclp_ro_*.*		
		tdlrsp_nr_*.*		
		tdlrsp_ro_*.*		
		tdsp_nr_*.*		
		tdsp_ro_*.*		
		tsp_nr_*.*		
		tsp_ro_*.*		
		compare_external.for	cq	for functional unit testing
		compare_guidance.for		
		compare_sensor.for		
		ex_cp.for		
		read_tc.for		
		read_ex.for		
		p_tc_driver.com		
		p_test_*.for		
		p_lnk*.com		
		asp_nr_*.*		
		asp_ro_*.*		
		arsp_nr_*.*		
		arsp_ro_*.*		
		gsp_nr_*.*		
		gsp_ro_*.*		
		tsp_nr_*.*		

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DATE	ACTION	NAME	Requester (initials)	Remarks
		tsp_ro_*.*		
		tdsp_nr_*.*		
		tdsp_ro_*.*		
		tdlrsp_nr_*.*		
		tdlrsp_ro_*.*		
		compare_runparam.for		
	create element (kjh)	commons.for_inc	cq	utility file for requirements- based testing
		struct.for_inc		
4/6/95	fetch (kjh)	*.for_inc	cq	for functional unit testing
		clp_*.*	dbt	for subframe testing
		sp_001.*		
		gpsf_gpsf_*.*		
4/7/95	fetch (kjh)	frame_*.*	dbt	for frame testing
		traj_*.*	dbt	for trajectory testing
		gp_nr_*.*	cq	for functional unit testing
		gp_ro_*.*		
		aeclp_nr_*.*		
		aeclp_ro_*.*		
		reclp_nr_*.*		
		reclp_ro_*.*		
		crecp_nr_*.*		
		crecp_ro_*.*		
		cp_nr_*.*		
		p_lnk*.com		
		p_test*.for		
		p_lnk*.com	cq	to check link files for debug statements
	reserve (kjh)	p_lnkcrecp.com	cq	for SDCR #32
		p_lnkreclp.com		
		p_lnkcp.com		
	fetch (kjh)	m_aeclp_st*.*	dbt	for Mercury structural testing
		m_asp_st_*.*		
		m_reclp_st*.*		
		m_gp_st*.*		
		m_tdlrsp_st*.*		
	replace (kjh)	p_lnk*.com	cq	for SDCR #32
	fetch (kjh)	p_lnkcrecp.com	cq	for Pluto functional unit testing
		p_lnkreclp.com		
		p_lnkcp.com		
		sp_001.*		for Pluto subframe testing
		gpsf_*.*		
		clp_*.*		

LIBRARY: DISK\$HOKIE:[GCS.CMS.VER_CASES]

DATE	ACTION	NAME	Requester (initials)	Remarks
		frame_*.*		for Pluto frame testing
		p_test_sp.for		for Pluto subframe testing
		p_test_gpsf.for		
		p_test_clp.for		
		p_test_frame.for		for Pluto frame testing
		p_sp_driver.com		for Pluto subframe testing
		p_clp_driver.com		
		p_gpsf_driver.com		
		p_lnksp.com		
		p_lnkgpsf.com		
		p_lnkclp.com		
		p_lnkframe.com		for Pluto frame testing
		ex_cp.for		for Pluto subframe testing
		p_test_gpsf.for		
		p_frame_driver.com		for pluto frame testing
		p_gpsf_driver.com		for Pluto subframe testing
	reserve (kjh)	p_gpsf_driver.com	cq	for SDCR #33
		p_clp_driver.com		
	replace (kjh)	p_gpsf_driver.com	cq	for SDCR #33
		p_clp_driver.com		
	fetch (kjh)	p_gpsf_driver.com	cq	for Pluto subframe testing
		p_clp_driver.com		
		traj_*.*	cq	for Pluto trajectory testing
		traj.com		
4/7/95	fetch (kjh)	run_traj.com	cq	for Pluto trajectory testing
4/10/95	fetch (kjh)	asp_pst_*.*	cq	to verify that these test cases are necessary given changes to Pluto ASP module
	reserve (kjh)	m_asp_st_004, 005, 006.*	dbt	for SDCR #34
		m_run_traj.com	dbt	for SDCR #35
	replace (kjh)	m_asp_st_004, 005, 006.*	dbt	for SDCR #34
		m_run_traj.com	dbt	for SDCR #35
	fetch (kjh)	m_run_traj.com	dbt	to rerun Mercury trajectory tests
		m_asp_st_*.*	dbt	to rerun Mercury structural test cases for ASP
	reserve (kjh)	asp_pst_002.*	cq	for SDCR #36
	replace (kjh)	asp_pst_002.*	cq	for SDCR #36
	fetch (kjh)	asp_pst_*.*	cq	for Pluto structural testing
		gp_pst_*.*		
		aeclp_pst_*.*		
		reclp_pst_*.*		

LIBRARY: DISK\$HOKIE:[GCS.CMS.VER_CASES]

DATE	ACTION	NAME	Requester (initials)	Remarks
		p_lnkasp.com		
		p_lnkgp.com		
		p_lnkaeclp.com		
		p_lnkreclp.com		
		p_test_asp.for		
		p_test_gp.for		
		p_test_aeclp.for		
		p_test_reclp.for		
		compare_external.for		
		compare_guidance.for		
		compare_runparam.for		
		compare_sensor.for		
		ex_cp.for		
		read_tc.for		
		p_tc_driver.com		
		read_ex.for		
	delete element (kjh)	gp_nr_053.ex1	cq	for SDCR #37
		tdlrsp_nr_006.ex,.tc		
	remove element (kjh)	tdlrsp_pst_*. * from pluto	kjh	test cases no longer needed
	delete element (kjh)	tdlrsp_pst_*. *	cq	for SDCR #37
4/14/95	copy element (kjh)	run_traj.com to p_run_traj.com	cq	nee to make this file Pluto specific
		traj.com to p_traj.com		
	reserve (kjh)	p_run_traj.com	cq	for SDCR #38
	replace (kjh)	p_run_traj.com	cq	for SDCR #38
	create element (kjh)	p_build.com	cq	for Pluto trajectory testing
		m_build.com	dbt	for Mercury trajectory testing

Appendix D: Software Quality Assurance Records for the Guidance and Control Software Project

Author: Kelly J. Hayhurst, NASA Langley Research Center

This document was produced as part of Guidance and Control Software (GCS) Project conducted at NASA Langley Research Center. Although some of the requirements for the Guidance and Control Software application were derived from the NASA Viking Mission to Mars, this document does not contain data from an actual NASA mission.

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D.1 Introduction

As described in the Radio Technical Commission for Aeronautics RTCA/DO-178B guidelines, "Software Considerations in Airborne Systems and Equipment Certification," (ref. D.1) the Software Quality Assurance (SQA) process provides evidence that the software life cycle processes satisfy their objectives and that the resultant software conforms to its requirements. The primary means that SQA provides this evidence is by assuring that the software life cycle processes are performed in compliance with the approved software plans and standards. The *Software Quality Assurance Records* for the GCS project consist of the reports from reviews that are held during each of the development processes and the status logs for all of the change reports for the project's life cycle data.

An SQA report was produced at the closure of each development process for each of the two GCS implementations, Mercury and Pluto. The basic form of all the reports is an introduction followed by the overview of the review sessions and a listing of any problem reports that are issued. Each report documents the SQA approval for a particular stage of the implementation's development and contains an acceptance statement signed by the SQA representative as part of the report.

For each of the GCS implementations, the following reports are included in this document: Preliminary Design Review Report, Design Review Report, and Test Completion Report for Integration. There is also a Test Readiness Review Report for Requirements-based Testing that was conducted at the start of the integration process. Because only one set of requirements-based test cases was developed for the project, the review of those cases was not implementation specific.

The status logs for all of the change reports for the project's life cycle data were handwritten and have been copied and appended to this document.

D.2 Software Quality Assurance Records for Mercury

Software Quality Assurance Records

Record Type: Preliminary Design Review Report	Closure Date: 5/31/94
GCS Implementation: Mercury	
Relevant Configuration Items: Design Description for Mercury Software Verification Procedures (for Design Reviews), Design Review Checklist, Requirements Traceability Matrix	
Notes: Overview Meeting held on 12/2/93 6 Review Sessions held 12/7/93-12/10/93 Participants: Kelly Hayhurst (SQA representative/Moderator) Debbie Taylor (Verification Analyst/Recorder, Inspector) Andy Boney (Programmer/Reader, Inspector) Bernice Becher (System Analyst/Inspector) The design description has many substantial problems -- and they were recorded on 13 Problem Reports: PRs # 1-13. Due to the significant problems identified in these review sessions, another design review should be scheduled to re-inspect the entire design description. Further, PR #14 was also issued as the result of a change to the GCS specification (Spec mod 2.3-2) and was completed and approved. All problem reports (#1 - 13) were completed and approved by the SQA representative. This report only signifies the closure of what will now be called the preliminary design review phase. (That is, this report does not signify the completion of the design process.) The design is now ready for the next Design Review sessions.	
Problem Reports: #1 - 13, #14	
SQA representative signature Original Signed by Kelly Hayhurst	

Software Quality Assurance Records

Record Type: Design Review Report	Closure Date: 8/30/94
GCS Implementation: Mercury	
Relevant Configuration Items: Design Description for Mercury Software Verification Procedures (for Design Reviews), Design Review Checklist, Requirements Traceability Matrix	
Notes: <p>Overview Meeting held on 6/3/94</p> <p>2 Review Sessions held 6/29/94</p> <p>Participants: Kelly Hayhurst (SQA representative/Moderator)</p> <p style="padding-left: 40px;">Debbie Taylor (Verification Analyst/Recorder, Inspector)</p> <p style="padding-left: 40px;">Andy Boney (Programmer/Reader, Inspector)</p> <p style="padding-left: 40px;">Bernice Becher (System Analyst/Inspector)</p> <p>An informal review of the design was conducted by the System Analyst prior to the review sessions. The System Analyst initiated Problem Report #15 to address some problems in the high-level structure charts in the design, because she thought the review of the design would be easier if the corrections were made prior to the actual inspection sessions. PR #15 was completed and approved prior to the review sessions.</p> <p>A number of problems were identified in the review sessions -- and they were recorded on 7 Problem Reports: PRs # 16 - 22.</p> <p>Further, PR #23 was also issued as the result of a change to the GCS specification (Spec mod 2.3-4) and was completed and approved.</p> <p>All problem reports (#16 - 22) were completed and approved by the SQA representative.</p> <p>This report signifies the closure of the design process for Mercury.</p> <p>The design is now ready for the code process.</p>	
Problem Reports: #15, #16 - 22, #23	
SQA representative signature Original Signed by Kelly Hayhurst	

Software Quality Assurance Records

Record Type: Code Review Report	Closure Date: 12/10/94
GCS Implementation: Mercury	
Relevant Configuration Items: Source Code for Mercury Software Verification Procedures (for Code Reviews), Code Review Checklist, Requirements Traceability Matrix	
Notes: Overview Meeting held on 10/4/94 2 Review Sessions held 10/19/94 Participants: Kelly Hayhurst (SQA representative/Moderator) Debbie Taylor (Verification Analyst/Recorder, Inspector) Andy Boney (Programmer/Reader, Inspector) Bernice Becher (System Analyst/Inspector) During the development of the source code, the programmer identified a problem in the design description. The programmer initiated Problem Report #24. PR #24 was completed and approved by the SQA representative prior to submitting the code for review. A number of problems were identified in the review sessions -- and they were recorded on 2 Problem Reports: PRs # 25 - 26. All problem reports (#25-26) were completed and approved by the SQA representative. This report signifies the closure of the code process for Mercury. The source code is now ready for the integration process.	
Problem Reports: #24, #25 - 26	
SQA representative signature Original Signed by Kelly Hayhurst	

Software Quality Assurance Records

Record Type: Test Completion Report for the Integration Process	Closure Date: 4/15/95
GCS Implementation: Mercury	
Relevant Configuration Items: <div style="margin-left: 20px;"> Requirements-based Test Cases and Requirements Traceability Matrix Multiple Condition/Decision Coverage Tables for all Mercury Source Code, Structure diagrams of the source code, Structure-based Test Cases Software Verification Procedures </div>	
Notes: <div style="margin-left: 20px;"> <p>The requirements-based testing started on December 14, 1994.</p> <p>In response to Spec mod # 2.3-6, the programmer initiated PR #27. PR #27 was completed and approved.</p> <p>PR #28 was issued as a result of functional unit testing.</p> <p>PR #29 was initiated by the verification analyst, but determined to not be a problem.</p> <p>PR #30 was initiated and completed in response to Spec mod #2.3-7</p> <p>Trajectory testing (with complete regression testing of all requirements-based test cases) was completed on 4/7/95.</p> <p>Several informal reviews of the structure-based test cases were held. Final review and approval of Structure-based test cases was 4/6/95</p> <p style="margin-left: 40px;">Participants: Kelly Hayhurst (SQA representative)</p> <p style="margin-left: 80px;">Debbie Taylor (Verification Analyst)</p> <p>During structure-based testing, a problem was found in some of the test cases and SDCR #34 was issued and completed to correct those test cases.</p> <p>No problems were found in the Mercury code during structure-based testing.</p> <p>All Integration was completed 4/10/95.</p> <p>All problem reports (#27-30) were completed and approved by the SQA representative.</p> <p>This report signifies the closure of the integration process for Mercury.</p> </div>	
Problem Reports: #27 - #30	
SQA representative signature Original Signed by Kelly Hayhurst	

D.3 Software Quality Assurance Records for Pluto

Software Quality Assurance Records

Record Type: Preliminary Design Review Report	Closure Date: 6/29/94
GCS Implementation: Pluto	
Relevant Configuration Items: Design Description for Pluto Software Verification Procedures (for Design Reviews), Design Review Checklist, Requirements Traceability Matrix	
Notes: Overview Meeting held on 8/26/93 9 Review Sessions held 9/16/93 - 10/15/93 Participants: Kelly Hayhurst (SQA representative/Moderator) Rob Angellatta (Verification Analyst/Recorder, Inspector) Paul Carter (Programmer/Reader, Inspector) Bernice Becher (System Analyst/Inspector) The Software Development Standards state that the design should be "balanced" within the <i>teamwork</i> tool prior to submitting the design for review. However, the design as presented for the review was not balanced. The review team decided to proceed with the review. Many substantial problems were identified in the design description -- and they were recorded on 13 Problem Reports: PRs # 1-13. Due to the significant problems identified in these review sessions, another design review should be scheduled to re-inspect the entire design description. Further, PR #14 was also issued as the result of a change to the GCS specification (Spec mod 2.3-2) and was completed and approved. The design is now ready for the next Design Review sessions. This report only signifies the closure of what will now be called the preliminary design review phase. All problem reports (#1 - 14) were completed and approved by the SQA representative. The design description is now ready to proceed to the next Design Review sessions.	
Problem Reports: #1 - 13, #14	
SQA representative signature Original Signed by Kelly Hayhurst	

Software Quality Assurance Records

Record Type: Design Review Report	Closure Date: 8/26/94
GCS Implementation: Pluto	
Relevant Configuration Items: Design Description for Pluto Software Verification Procedures (for Design Reviews), Design Review Checklist, Requirements Traceability Matrix	
Notes: 2 Review Sessions held 7/13/94 Participants: Kelly Hayhurst (SQA representative/Moderator) Patrick Quach (Verification Analyst/Recorder, Inspector) Rob Angellatta (Programmer/Reader, Inspector) Bernice Becher (System Analyst/Inspector) Some problems were identified in the review sessions -- and they were recorded on 5 Problem Reports: PRs # 15 - 19. All problem reports (#15 - 19) were completed and approved by the SQA representative. This report signifies the closure of the design process for Pluto. The design is now ready for the code process.	
Problem Reports: #15 - 19	
SQA representative signature Original Signed by Kelly Hayhurst	

Software Quality Assurance Records

Record Type: Code Review Report	Closure Date: 12/5/94
GCS Implementation: Pluto	
Relevant Configuration Items: Source Code for Pluto Software Verification Procedures (for Code Reviews), Code Review Checklist, Requirements Traceability Matrix	
Notes: <p>Overview Meeting held on 10/26/94</p> <p>2 Review Sessions held 11/16/94</p> <p>Participants: Kelly Hayhurst (SQA representative/Moderator)</p> <p style="padding-left: 40px;">Patrick Quach (Verification Analyst/Recorder, Inspector)</p> <p style="padding-left: 40px;">Philip Morris (Programmer/Reader, Inspector)</p> <p style="padding-left: 40px;">Bernice Becher (System Analyst/Inspector)</p> <p>During the development of the source code, Spec mod #2.3-4 was issued. The programmer initiated PR #20 in response to the requirements change. PR #20 was completed and approved prior to submitting the code for review.</p> <p>A number of problems were identified in the review sessions -- and they were recorded on 3 Problem Reports: PRs # 21 - 23.</p> <p>All problem reports (#20 - 23) were completed and approved by the SQA representative.</p> <p>This report signifies the closure of the code process for Pluto.</p> <p>The Pluto source code is now ready for the integration process.</p>	
Problem Reports: #20, #21 - 23	
SQA representative signature Original Signed by Kelly Hayhurst	

Software Quality Assurance Records

Record Type: Test Completion Report for the Integration Process	Closure Date: 4/15/95
GCS Implementation: Pluto	
Relevant Configuration Items: <div style="margin-left: 20px;"> Requirements-based Test Cases and Requirements Traceability Matrix Multiple Condition/Decision Coverage Tables for all Mercury Source Code, Structure diagrams of the source code, Structure-based Test Cases Software Verification Procedures (for Testing) </div>	
Notes: <div style="margin-left: 20px;"> The requirements-based testing started on January 4, 1994. PRs #24 and #25 were issued as a result of functional unit testing. PR #26 was issued as a result of frame testing. PR #27 was issued as a result of trajectory testing Trajectory testing (with complete regression testing of all requirements-based test cases) was completed on 4/7/95. Final review and approval of Structure-based test cases for Pluto was 4/10/95 Participants: Kelly Hayhurst (SQA representative) Patrick Quach (Verification Analyst) No problems were found in the Pluto code during structure-based testing. All Integration testing was completed 4/11/95. All problem reports (#24 - 27) were completed and approved by the SQA representative. This report signifies the closure of the integration process for Pluto. </div>	
Problem Reports: #24 - 27	
SQA representative signature Original Signed by Kelly Hayhurst	

D.4 Software Quality Assurance Record for Test Readiness Review for Requirements-based Testing

Software Quality Assurance Records

Record Type: Test Readiness Review for Requirements-based Testing	Closure Date: 12/14/95
GCS Implementation: N/A	
Relevant Configuration Items: Requirements-based Test Cases and Requirements Traceability Matrix Software Verification Procedures (for Testing)	
Notes: Review of the Requirements-based test cases was held 12/14/94 Participants: Kelly Hayhurst (SQA representative) Patrick Quach (Verification Analyst) Debbie Taylor (Verification Analyst) The Requirements Traceability Matrix was completed -- all requirements identified in the matrix were covered by at least one test case. No problems were found in the requirements-based test cases. This report signifies that the requirements for requirements-based testing as described in the Software Verification Plan have been satisfied. The executable object code for each of the GCS implementations can now be tested.	
Problem Reports: None	
SQA representative signature Original Signed by Kelly Hayhurst	

D.5 Status Logs for Problem Reports

Problem Reports Assigned for Action

Implementation: Mercury

PR #	Date Assigned	Assigned to:	Date Received (by Project Leader)	Date Approved (by SQA)	# of Action Reports	Comments
1	12/20/93	Andy Boney -- Prog	1/4/94	1.14.94	1	To SQA 1/6/94
2	1/18/94	Andy Boney -- Prog	1/24/94	1/27/94	1	To SQA 1/24/94
3	1/27/94	Andy Boney -- Prog	2/9/94	2/15/94	1	To SQA 2/11/94
4	2/15/94	Andy Boney -- Prog	3/7/94	3/8/94	1	
5	3/17/94	Andy Boney -- Prog	3/24/94	3/24/94	1	signed by kjh for SQA
6	3/24/94	Andy Boney -- Prog	3/29/94	3/30/94	1	signed by kjh for SQA
7	3/30/94	Andy Boney -- Prog	4/20/94	4/20/94	1	GP
8	4/20/94	Andy Boney -- Prog	4/22/94	4/22/94	1	AECLP
9	4/22/94	Andy Boney -- Prog	4/26/94	4/28/94	1	RECLP
10	4/28/94	Andy Boney -- Prog	5/6/94	5/6/94	1	CP
11	5/6/94	Andy Boney -- Prog	5/12/94	5/12/94	1	Data Dictionary
12	5/12/94	Andy Boney -- Prog	5/16/94	5/17/94	1	Misc. typos, etc.
13	5/19/94	Andy Boney -- Prog	5/31/94	5/31/94	1	PATs
14	5/31/94	Andy Boney -- Prog	5/31/94	5/31/94	1	Scheduling -- Spec Mod 2.3-2
15	6/17/94	Andy Boney -- Prog	6/22/94	6/22/94	1	High Level/PATs
16	6/30/94	Andy Boney -- Prog	7/6/94	7/7/94	1	High Level/PATs
17	7/7/94	Andy Boney -- Prog	7/20/94	7/20/94	1	SP
18	7/20/94	Andy Boney -- Prog		7/25/94	1	GP *signed off by Bernice Becher
19	7/26/94	Andy Boney -- Prog	8/3/94	8/3/94	1	RECLP, AECLP, CLP
20	8/3/94	Andy Boney -- Prog	8/12/94	8/15/94	1	CP
21	8/15/94	Andy Boney -- Prog	8/18/94	8/18/94	1	Limit Checking
22	8/18/94	Andy Boney -- Prog	8/23/94	8/23/94	1	Intro & Misc.
23	8/25/94	Andy Boney -- Prog	8/29/94	8/30/94	1	Spec Mod
24	9/15/94	Andy Boney -- Prog	9/19/94	9/19/94	1	Minor updates to design due to coding

Problem Reports Assigned for Action

Implementation: Mercury

[illegible]

Problem Reports Assigned for Action

Implementation: Pluto

PR #	Date Assigned	Assigned to:	Date Received (by Project Leader)	Date Approved (by SQA)	# of Action Reports	Comments
1.0	10/28/93	Paul Carter -- Prog	12/21/93	1/14/94	1	To SQA 1/11/94
2.0	1/21/94	Paul Carter -- Prog	2/11/94	2/15/94	1	To SQA 2/11/94
3.0	4/11/94	Rob Angellatta -- Prog	4/19/94	4/20/94	1	To SQA 4/19/94
4.0	4/20/94	Rob Angellatta -- Prog	4/29/94	5/2/94	1	ARSP
5.0	5/2/94	Rob Angellatta -- Prog	5/2/94	5/2/94	1	ASP
6.0	5/2/94	Rob Angellatta -- Prog	5/4/94	5/4/94	1	GSP
7.0	5/4/94	Rob Angellatta -- Prog	5/6/94	5/6/94	1	TDLRSP
8.0	5/6/94	Rob Angellatta -- Prog	5/9/94	5/10/94	1	TDSP
9.0	5/10/94	Rob Angellatta -- Prog	5/11/94	5/11/94	1	RECLP
10.0	5/11/94	Rob Angellatta -- Prog	5/31/94	6/2/94	1	AECLP
11.0	6/2/94	Rob Angellatta -- Prog	6/9/94	6/9/94	1	CP
12.0	6/9/94	Rob Angellatta -- Prog	6/20/94	6/20/94	1	GP
13.0	6/21/94	Rob Angellatta -- Prog	6/27/94	6/28/94	1	High Level Diagrams
14.0	6/28/94	Rob Angellatta -- Prog	6/29/94	6/29/94	1	Spec Mod 2.3-2
15.0	7/18/94	Rob Angellatta -- Prog	7/21/94	7/21/94	1	SP, P-Specs 1.2, 1.3, 1.5, 1.7
16.0	7/21/94	Rob Angellatta -- Prog	7/22/94	7/22/94	1	CLP, P-Specs 1.8, 3.2, 3.3, 3.4
17.0	7/22/94	Rob Angellatta -- Prog	7.28.94	7.29.94	1	DFDs, Data Dictionary
18.0	7/29/94	Rob Angellatta -- Prog	8/2/94	8/2/94	1	GP
19.0	8/11/94	Rob Angellatta -- Prog	8/24/94	8/26/94	1	Intro & Syntax clean up
20.0	9/16/94	Rob Angellatta -- Prog	9/16/94	9/16/94	1	Spec Mod 2.3-4
21.0	11/17/94	Philip Morris -- Prog	11/22/94	11/22/94	1	Design Corrections / Code Review
22.0	11/22/94	Philip Morris -- Prog	11/29/94	11/29/94	1	Design Corrections / Code Review
23.0	11/29/94	Philip Morris -- Prog	12/5/94	12/5/94	1	Code Corrections / Code Review
24.0	1/10/95	Philip Morris -- Prog	1/11/95	1/13/95	1	Unit Test Problems
25.0	1/13/95	Philip Morris -- Prog	1/13/95	1/13/95	1	CP

Problem Reports Assigned for Action

Implementation: Pluto

[illegible]

D.6 Status Logs for Support Documentation Change Reports

Support Documentation Change Reports Assigned for Action

Configuration Item: Software Development Standards

SDCR #	Date Assigned	Assigned to:	Date Received (by Project Leader)	Date Approved (by SQA)	Comments
1	7/27/93	Kelly Hayhurst	7/27/93		Original report not available from Dr. Liceaga
2	8/30/93	Kelly Hayhurst	8/30/93	8/30/93	okayed by G. Finelli -- acting SQA
3	8/30/93	Kelly Hayhurst			canceled by kjh
3	1/3/94	Kelly Hayhurst	1/4/94	1/5/94	
4	5/6/94	Kelly Hayhurst	5/12/94	5/12/94	Code Standards
5	5/16/94	Kelly Hayhurst	5/23/94	5/23/94	change from 3 to 2 implementations
6	5/23/94	Kelly Hayhurst	5/24/94	5/24/94	Formal Modifications
7	5/25/94	Kelly Hayhurst	5/25/94	5/25/94	Design Standards
8	5/25/94	Kelly Hayhurst	5/25/94	5/25/94	Bolding of spec
9	5/25/94	Kelly Hayhurst	5/25/94	5/25/94	More code standards

Support Documentation Change Reports Assigned for Action

Configuration Item: Software Configuration Management Plan

SDCR #	Date Assigned	Assigned to:	Date Received (by Project Leader)	Date Approved (by SQA)	Comments
1	8/31/93	Laura Smith	8/31/93	9/1/93	
2	5/18/94	Laura Smith	5/18/94	5/18/94	change from 3 to 2 implementations
3	5/18/94	Laura Smith	5/19/94	5/19/94	change from transitional code phase to just code phase
4	5/19/94	Laura Smith	5/19/94	5/20/94	Misc/minor changes to process
5	12/19/94	Laura Smith	12/22/94	12/22/94	Problem Reporting procedures
6	1/25/95	Laura Smith	1/26/95	2/24/95	Misc/technical editing

Support Documentation Change Reports Assigned for Action

Configuration Item: Software Verification Plan

[illegible]

Support Documentation Change Reports Assigned for Action

Configuration Item: Software Verification Cases & Procedures

[illegible]

Support Documentation Change Reports Assigned for Action

Configuration Item: Software Verification Cases (test cases, models, drivers, etc.)

SDCR #	Date Assigned	Assigned to:	Date Received (by Project Leader)	Date Approved (by SQA)	Comments
1	8/25/94	Debbie Taylor	8/30/94	8/30/94	AECLP expected value files
2	8/25/94	Debbie Taylor	8/30/94	8/30/94	CRCP expected value files
3	9/12/94	Debbie Taylor	9/15/94	9/15/94	changing GP test cases & expected results
4	9/21/94	Debbie Taylor	12/2/94	12/2/94	Spec Mod 2.3-4 GP
5	9/21/94	Debbie Taylor	12/2/94	12/2/94	Spec Mod 2.3-4 AECLP
6	9/21/94	Debbie Taylor	12/2/94	12/2/94	Spec Mod 2.3-4 RECLP
7	9/21/94	Debbie Taylor	12/2/94	12/2/94	Spec Mod 2.3-4 CRCP
8	12/22/94	Patrick Quach	12/23/94	12/27/94	CP test cases
9	12/28/94	Patrick Quach	12/29/94	12/29/94	ASP test cases
10	1/11/95	Patrick Quach	1/12/95	1/12/95	CP test cases (related to SDCR #8)
11	2/7/95	Patrick Quach, Debbie Taylor	2/8/95	2/8/95	Subframe & Frame Drivers
12	2/8/95	Patrick Quach	2/9/95	2/10/95	Problem with subframe counter
13	2/11/95	Debbie Taylor	2/14/95	2/14/95	Test case drivers
14	2/15/95	Patrick Quach	2/16/95	2/16/95	Frame Test Cases
15	2/23/95	Patrick Quach	2/23/95	2/24/95	GP mathematica models
16	2/24/95	Debbie Taylor	2/24/95	2/24/95	GP structural test cases
17	2/24/95	Debbie Taylor	2/24/95	2/24/95	mathematica models
18	2/27/95	Debbie Taylor	2/27/95	2/27/95	Frame & Subframe command files
19	3/1/95	Debbie Taylor	3/1/95	3/1/95	oversight from SDCR #18
20	3/2/95	Debbie Taylor	3/2/95	3/2/95	everything from SDCR #18 still not correct
21	3/3/95	Patrick Quach	3/6/95	3/6/95	Pluto GP structural test cases
22	3/7/95	Debbie Taylor	3/7/95	3/7/95	problem with driver for structural tests
23	3/10/95	Debbie Taylor	3/10/95	3/10/95	problem with mathematica structural test case model for TDLRSP
24	3/15/95	Patrick Quach	3/23/95	3/23/95	Requirements-based test cases for Spec Mod 2.3-7

Support Documentation Change Reports Assigned for Action

Configuration Item: Software Verification Cases (test cases, models, drivers, etc.)

[illegible]

Support Documentation Change Reports Assigned for Action

Configuration Item: GCS Specification

Note: Version 2.2 of the GCS specification was the original version placed under configuration control. Changes 2.2-1 through 2.2-26 were made using a system of Formal Modifications prior to the project's adoption of the Support Documentation Change Reporting system. Copies of Formal Mods 2.2-1 through 2.2-26 are shown in the Support Documentation Change Reports document; however, there was not log for those reports.

[illegible]

D.7 References

- D.1 RTCA Special Committee 167. Software Considerations in Airborne Systems and Equipment Certification. Technical Report RTCA/DO-178B, Radio Technical Commission for Aeronautics, December 1992.

Appendix E: Problem Reports for the Pluto Implementation of the Guidance and Control Software Project

This document was produced as part of Guidance and Control Software (GCS) Project conducted at NASA Langley Research Center. Although some of the requirements for the Guidance and Control Software application were derived from the NASA Viking Mission to Mars, this document does not contain data from an actual NASA mission.

GCS Problem Report

page 1 of 18

PR #: 1.0	2. Planet: PLUTO	3. Discovery Date: Oct 15, 1993	4. Initiator & Role: Inspectors / Angellatta and Becher
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5. Activity at Discovery:

Development Phases	DR	CR	RC	RS	* Activity						R	O
Design	X											
Code												
Unit Testing												
Functional												
Structural												
Subframe Testing												
Frame Testing												
Top-Level Simulator												
Integration Testing												

6. Description of Problem:

The Teamwork balance operation indicates the existence of errors in the Pluto design. In accordance with the Software Design Standards, the Pluto design is to be modified such that the Teamwork balance operation indicates an absence of errors. The Teamwork balance report is attached.

7. Artifact Identification:

☒ Design Description ☐ Support Documentation Configuration Item:
☐ Source Code ☐ Other Pluto Design Description
☐ Executable Object Code

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
10/28/93	12/21/93	Paul Carter		1.1
12/29/93	12/29/93	George Finelli	Found minor problems with AR - returned to programmer to fix	1.1
1/3/94	1/10/94	Paul Carter		
1/14/94	1/14/94	George Finelli	Handwritten edits are already correct in Teamwork design	

10. Total # of Changes: 277

11. Total # of No Changes: 0

12. Initiator Signature & Date: Original Signed by Rob Angellatta Dec 28, 1993	13. SOA Signature & Date: Original Signed by George Finelli 1/14/94
--	---

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness

Problem Report Continuation

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a. Report #: Pluto PR #1.0

b. Notes/Explanation (Please reference appropriate section number):

DFD checking
Copyright 1986, 1987, 1988, 1989, 1990, 1991, 1992.
Cadre Technologies Inc.
All rights reserved.

Date: Wed 20 Oct 1993 Time: 11:36:16
Version: Teamwork 4.1

DFD checking options:
output : /cadre/reports/gcs_pluto_.dfd.context_1020.1135
config : /cadre/tsa/config_file
model : GCS_pluto_12_0
object : Context-Diagram
type of check: DFD Syntax and Balancing of Child Processes and C-Specs
extent : Sub-tree
dde expansion: Unlimited
report style : Verbose
unmatched : Report Unmatched C-Spec Flows

DFD: Context-Diagram:12 'GCS'

Flows:

1 The data flow 'INITIALIZATION_DATA' has an invalid definition.
Syntax error on line 3 reading '+':
+ A_ACCELERATION

2 The data flow 'PACKET' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: array(1..256) of integer*2;

No C-Spec balancing errors on this diagram.
No DFD/P-Spec balancing errors on this diagram.
No store-to-flow constituent errors on this diagram.
No syntax errors on this diagram.

DFD: 0;17 'INIT_RUN_GCS'

Flows:

3 The control flow 'INIT_DONE' has an invalid definition.
Syntax error on line 1 reading '*':
INIT_DONE;

4 The control flow 'RUN_DONE' has an invalid definition.
A comment is not terminated on line 6 reading '*':
DATA TYPE: logical*1;

5 The data flow 'FRAME_COUNTER' has an invalid definition.
A comment is not terminated on line 6 reading '*':
DATA TYPE: Integer*4;

No C-Spec balancing errors on this diagram.
No DFD/P-Spec balancing errors on this diagram.
No store-to-flow constituent errors on this diagram.
No syntax errors on this diagram.

PAT: 0-s1;13 'INIT_RUN_GCS PAT'

Input Events:

6 Column 2, DDE 'INIT_DONE' has a syntax error in its definition.
Syntax error on line 1 reading '*':
INIT_DONE;

7 Column 3, DDE 'RUN_DONE' has a syntax error in its definition.
A comment is not terminated on line 6 reading '*':
DATA TYPE: logical*1;

P-Spec: 1;9 'INIT_GCS'

No syntax errors in the I/O list.

Problem Report Continuation

page 3 of 18

Report #: Pluto PR #1.0

Notes/Explanation (Please reference appropriate section number):

DFD: 2:51 'RUN_OCS'

Bubbles:

Bubble 1 'AECLP' does not match the child DFD title 'AECLP-Axial Engine Data Expand and Compress'.

Bubble 10 'TDSP' does not match the child DFD title 'TDSP-Touch Down Sensor Processing Data Expand and Compress'.

Bubble 11 'TSP' does not match the child DFD title 'TSP-Temperature Sensor Processing Data Expand and Compress'.

Bubble 2 'ARSP' does not match the child DFD title 'ARSP-Altimeter Radar Data Expand and Compress'.

Bubble 3 'ASP' does not match the child DFD title 'ASP-Accelerometer Data Expand and Compress'.

Bubble 4 'CP' does not match the child DFD title 'CP-Communications Processing Data Expand and Compress'.

Bubble 6 'GSP' does not match the child DFD title 'GSP-Gyroscope Sensor Processing Data Expand and Compress'.

Bubble 7 'GP' does not match the child DFD title 'GP-Guidance Processing Data Expand and Compress'.

Bubble 8 'RECLP' does not match the child DFD title 'RECLP-Roll Engine Control Law Processing'.

Bubble 9 'TDLRSP' does not match the child DFD title 'TDLRSP-Touch Down Landing Radar Sensor Proc.Data Exp.&Comp.'.

P-Spec '2.12' exists, but bubble 12 is missing.

Flows:

'ACCEL_GS_IN' is not a constituent of store 'GUIDANCE_STATE'.

'ACCEL_GS_OUT' is not a constituent of store 'GUIDANCE_STATE'.

'ACCEL_RP_IN' is not a constituent of store 'RUN_PARAMETERS'.

'ACCEL_SO_IN' is not a constituent of store 'SENSOR_OUTPUT'.

'ACCEL_SO_OUT' is not a constituent of store 'SENSOR_OUTPUT'.

'AE_CMD' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: array(1..3) of Integer*2;

'AE_STATUS' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: Logical*1;

'AE_SWITCH' has an invalid definition.
A comment is not terminated on line 7 reading '':
DATA TYPE: Logical*1;

'AE_TEMP' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: Logical*1;

'ALPHA_MATRIX' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: array(1..3,1..3) of Real*8;

'ALT_RAD_GS_IN' is not a constituent of store 'GUIDANCE_STATE'.

'ALT_RAD_GS_OUT' is not a constituent of store 'GUIDANCE_STATE'.

'ALT_RAD_RP_IN' is not a constituent of store 'RUN_PARAMETERS'.

'ALT_RAD_SO_IN' is not a constituent of store 'SENSOR_OUTPUT'.

Problem Report Continuation

page 4 of 18

a. Report #: Pluto PR #1.0

b. Notes/Explanation (Please reference appropriate section number):

- 33 'ALT_RAD_SO_OUT' is not a constituent of store 'SENSOR_OUTPUT'.
- 34 'AR_ALTITUDE' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: array(0..4) of Real*R;
- 35 'AR_COUNTER' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: Integer*2;
- 36 'AR_FREQUENCY' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: Real*R;
- 37 'AR_STATUS' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: array(0..4) of Logical*1;
- 38 'ATMOSPHERIC_TEMP' is undefined.
- 39 'ATMOSPHERIC_TEMP' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: Real*R;
- 40 'AX_ENG_OS_IN' is not a constituent of store 'GUIDANCE_STATE'.
- 41 'AX_ENG_OS_OUT' is not a constituent of store 'GUIDANCE_STATE'.
- 42 'AX_ENG_RP_IN' is not a constituent of store 'RUN_PARAMETERS'.
- 43 'AX_ENG_SO_IN' is not a constituent of store 'SENSOR_OUTPUT'.
- 44 'A_ACCELERATION' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: array(1..3,0..4) of real*R;
- 45 'A_BIAS' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: array(1..3) of real*R;
- 46 'A_GAIN_0' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: array(1..3) of Real*R;
- 47 'A_SCALE' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: Integer*4;
- 48 'A_STATUS' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: array(1..3,0..3) of Logical*1;
- 49 'CHUTE_RELEASE' is not a constituent of store 'GUIDANCE_STATE'.
- 50 'CHUTE_RELEASED' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: Logical*1;
- 51 'CHUTE_REL_OS_IN' is not a constituent of store 'GUIDANCE_STATE'.
- 52 'CHUTE_REL_OS_OUT' is not a constituent of store 'GUIDANCE_STATE'.
- 53 'CL' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: Integer*2;

Problem Report Continuation

page 5 of 18

Report #: **Pluto PR #1.0**

Notes/Explanation (Please reference appropriate section number):

54 'CL' out of child DFD 2.4 is unmatched.

55 'CL' out of child DFD 2.7 is unmatched.

56 'COMM_GS_IN' is not a constituent of store 'GUIDANCE_STATE'.

57 'COMM_GS_OUT' is not a constituent of store 'GUIDANCE_STATE'.

58 'COMM_RP_IN' is not a constituent of store 'RUN_PARAMETERS'.

59 'COMM_SO_IN' is not a constituent of store 'SENSOR_OUTPUT'.

60 'COMM_SYNC_PATTERN' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: Integer*2;

61 'CONTOUR_ALTITUDE' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: array(1..100) of Real*8;

62 'CONTOUR_CROSSED' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: logical*1;

63 'CONTOUR_VELOCITY' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: array(1..100) of Real*8;

'C_STATUS' has an invalid definition.
A comment is not terminated on line 7 reading '':
DATA TYPE: Logical*1;

65 'DELTA_T' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: Real*8;

66 'DELTA_T' out of child DFD 2.8 is unmatched.

67 'DROP_HEIGHT' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: Real*8;

68 'DROP_SPEED' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: Real*8;

69 'ENGINES_OFF' is undefined.

70 'ENGINES_ON_ALTITUDE' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: Real*8;

71 'FRAME_BEAM_UNLOCKED' has an invalid definition.
A comment is not terminated on line 7 reading '':
DATA TYPE: array(1..4) of Integer*4;

72 'FRAME_COUNTER' out of child DFD 2.2 is unmatched.

73 'FRAME_ENGINES_IGNITED' has an invalid definition.
A comment is not terminated on line 7 reading '':
DATA TYPE: Integer*4;

74 'FULL_UP_TIME' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: Real*8;

Problem Report Continuation

page 6 of 18

a. Report #: **Pluto PR #1.0**

b. Notes/Explanation (Please reference appropriate section number):

- 75 'GA' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: Real*8;
- 76 'GAX' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: Real*8;
- 77 'GPY' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: Real*8;
- 78 'GPI' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: Real*8;
- 79 'GP2' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: Real*8;
- 80 'GP_ALTITUDE' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: array(0..4) of Real*8;
- 81 'GP_ATTITUDE' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: array(1..3,1..3,0..4) Real*8;
- 82 'GP_ATTITUDE' out of child DFD 2.1 is unmatched.
- 83 'GP_PHASE' has an invalid definition.
A comment is not terminated on line 6 reading '*':
DATA TYPE: Integer*4;
- 84 'GP_ROTATION' has an invalid definition.
A comment is not terminated on line 6 reading '*':
DATA TYPE: array(1..3,1..3) Real*8;
- 85 'GP_VELOCITY' has an invalid definition.
A comment is not terminated on line 6 reading '*':
DATA TYPE: array(1..3,0..4) of Real*8;
- 86 'GQ' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: array(1..2) of Real*8;
- 87 'GR' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: array(1..2) of Real*8;
- 88 'GRAVITY' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: Real*8;
- 89 'GUIDE_GS_IN' is not a constituent of store 'GUIDANCE_STATE'.
- 90 'GUIDE_GS_OUT' is not a constituent of store 'GUIDANCE_STATE'.
- 91 'GUIDE_RP_IN' is not a constituent of store 'RUN_PARAMETERS'.
- 92 'GUIDE_SO_IN' is not a constituent of store 'SENSOR_OUTPUT'.
- 93 'GV' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: array(1..2) of Real*8;

Problem Report Continuation

page 7 of 18

Report #: Pluto PR #1.0

Notes/Explanation (Please reference appropriate section number):

94 'GVE' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: Real*8;

95 'GVEI' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: array(1..2) of Real*8;

96 'GW' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: array(1..2) of Real*8;

97 'GWI' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: array(1..2) of Real*8;

98 'GYRO_GS_IN' is not a constituent of store 'GUIDANCE_STATE'.

99 'GYRO_GS_OUT' is not a constituent of store 'GUIDANCE_STATE'.

100 'GYRO_RP_IN' is not a constituent of store 'RUN_PARAMETERS'.

101 'GYRO_SO_IN' is not a constituent of store 'SENSOR_OUTPUT'.

102 'GYRO_SO_OUT' is not a constituent of store 'SENSOR_OUTPUT'.

103 'G1' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: Real*8;

104 'G2' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: Real*8;

105 'G3' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: Real*8;

106 'G4' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: Real*8;

107 'G_GAIN_0' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: array(1..3) of Real*8;

108 'G_OFFSET' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: array(1..3) of Real*8;

109 'G_ROTATION' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: array(1..3,0..4) of Real*8;

110 'G_STATUS' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: Logical*1;

111 'INIT_GS_OUT' is not a constituent of store 'GUIDANCE_STATE'.

112 'INIT_RP_OUT' is not a constituent of store 'RUN_PARAMETERS'.

113 'INTERNAL_CMD' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: array(1..3) of Real*8;

114 'K_ALT' has an invalid definition.
A comment is not terminated on line 6 reading '':

Problem Report Continuation

page 8 of 18

a. Report #: Pluto PR #1.0

b. Notes/Explanation (Please reference appropriate section number):

- DATA TYPE: array(0..4) of Integer*4;
- 115 'K_MATRIX' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: array(1..3,1..3,0..4) Integer*4;
- 116 'MAX_NORMAL_VELOCITY' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: real*8;
- 117 'MAX_NORMAL_VELOCITY' out of child DFD 2.7 is unmatched.
- 118 'M1' has an invalid definition.
A comment is not terminated on line 7 reading '':
DATA TYPE: Integer*2;
- 119 'M2' has an invalid definition.
A comment is not terminated on line 7 reading '':
DATA TYPE: Integer*2;
- 120 'M3' has an invalid definition.
A comment is not terminated on line 7 reading '':
DATA TYPE: Integer*2;
- 121 'M4' has an invalid definition.
A comment is not terminated on line 7 reading '':
DATA TYPE: Integer*2;
- 122 'OMEGA' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: real*8;
- 123 'PE_INTEGRAL' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: real*8;
- 124 'PE_MAX' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: array(1..2) of real*8;
- 125 'PE_MIN' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: array(1..2) of real*8;
- 126 'P1' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: real*8;
- 127 'P2' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: real*8;
- 128 'P3' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: real*8;
- 129 'P4' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: real*8;
- 130 'RE_CMD' has an invalid definition.
A comment is not terminated on line 8 reading '':
DATA TYPE: Integer*2;
- 131 'RE_STATUS' has an invalid definition.
A comment is not terminated on line 5 reading '':

Problem Report Continuation

page 9 of 18

Report #: Pluto PR #1.0

Notes/Explanation (Please reference appropriate section number):

DATA TYPE: logical*1;

132 'RE_SWITCH' has an invalid definition.
A comment is not terminated on line 6 reading '*':
DATA TYPE: logical*1;

133 'ROL_ENG_OS_IN' is not a constituent of store 'GUIDANCE_STATE'.

134 'ROL_ENG_OS_OUT' is not a constituent of store 'GUIDANCE_STATE'.

135 'ROL_ENG_RP_IN' is not a constituent of store 'RUN_PARAMETERS'.

136 'ROL_ENG_SO_IN' is not a constituent of store 'SENSOR_OUTPUT'.

137 'TDLRSP_SWITCH' is undefined.

138 'TDLR_ANGLES' has an invalid definition.
A comment is not terminated on line 6 reading '*':
DATA TYPE: array(1..3) of real*R;

139 'TDLR_GAIN' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: real*R;

140 'TDLR_LOCK_TIME' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: real*R;

141 'TDLR_OFFSET' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: real*R;

142 'TDLR_STATE' has an invalid definition.
A comment is not terminated on line 6 reading '*':
DATA TYPE: array(1..4) logical*1;

143 'TDLR_STATUS' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: array(1..4) of logical*1;

144 'TDLR_VELOCITY' has an invalid definition.
A comment is not terminated on line 6 reading '*':
DATA TYPE: array(1..3,0..4) of real*R;

145 'TDSP_SWITCH' is undefined.

146 'TDS_STATUS' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: logical*1;

147 'TD_OS_IN' is not a constituent of store 'GUIDANCE_STATE'.

148 'TD_OS_OUT' is not a constituent of store 'GUIDANCE_STATE'.

149 'TD_LND_RAD_OS_IN' is not a constituent of store 'GUIDANCE_STATE'.

150 'TD_LND_RAD_OS_OUT' is not a constituent of store 'GUIDANCE_STATE'.

151 'TD_LND_RAD_RP_IN' is not a constituent of store 'RUN_PARAMETERS'.

152 'TD_LND_RAD_SO_IN' is not a constituent of store 'SENSOR_OUTPUT'.

153 'TD_LND_RAD_SO_OUT' is not a constituent of store 'SENSOR_OUTPUT'.

Problem Report Continuation

page 10 of 18

a. Report #: Pluto PR #1.0

b. Notes/Explanation (Please reference appropriate section number):

154 'TD_SENSED' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: logical*1;

155 'TD_SO_OUT' is not a constituent of store 'SENSOR_OUTPUT'.

156 'TEMP_GS_IN' is not a constituent of store 'GUIDANCE_STATE'.

157 'TEMP_GS_OUT' is not a constituent of store 'GUIDANCE_STATE'.

158 'TEMP_RP_IN' is not a constituent of store 'RUN_PARAMETERS'.

159 'TEMP_SO_OUT' is not a constituent of store 'SENSOR_OUTPUT'.

160 'TE_DROP' has an invalid definition.
A comment is not terminated on line 7 reading '':
DATA TYPE: real*R;

161 'TE_INIT' has an invalid definition.
A comment is not terminated on line 6 reading '':
DATA TYPE: real*R;

162 'TE_INTEGRAL' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: real*R;

163 'TE_INTEGRAL' out of child DFD 2.7 is unmatched.

164 'TE_LIMIT' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: real*R;

165 'TE_MAX' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: array(1..2) of real*R;

166 'TE_MIN' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: array(1..2) of real*R;

167 'THETA' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: real*R;

168 'THETA1' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: real*R;

169 'THETA2' has an invalid definition.
A comment is not terminated on line 5 reading '':
DATA TYPE: real*R;

170 'TS_STATUS' has an invalid definition.
A comment is not terminated on line 7 reading '':
DATA TYPE: array(1..2) of logical*1;

171 'T1' has an invalid definition.
A comment is not terminated on line 7 reading '':
DATA TYPE: real*R;

172 'T2' has an invalid definition.
A comment is not terminated on line 7 reading '':
DATA TYPE: real*R;

173 'T3' has an invalid definition.
A comment is not terminated on line 7 reading '':
DATA TYPE: real*R;

Problem Report Continuation

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Report #: Pluto PR #1.0

Notes/Explanation (Please reference appropriate section number):

174 'T4' has an invalid definition.
A comment is not terminated on line 7 reading '*':
DATA TYPE: real*R;

175 'VELOCITY_ERROR' has an invalid definition.
A comment is not terminated on line 7 reading '*':
DATA TYPE: real*R;

176 'YE_INTEGRAL' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: real*R;

177 'YE_MAX' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: array(1..2) of real*R;

178 'YE_MIN' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: array(1..2) of real*R;

179 The control flow 'SUBFRAME_COUNTER' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: integer*2;

180 The control flow 'SUBFRAME_COUNTER' is defined in the Data Dictionary as a
data flow.

Stores:

31 The store 'GUIDANCE_STATE' is defined in the Data Dictionary as a flow.

32 The store 'GUIDANCE_STATE' is undefined.

183 The store 'RUN_PARAMETERS' is defined in the Data Dictionary as a flow.

184 The store 'RUN_PARAMETERS' is undefined.

185 The store 'SENSOR_OUTPUT' is defined in the Data Dictionary as a flow.

186 The store 'SENSOR_OUTPUT' is undefined.

No C-Spec balancing errors on this diagram.
No syntax errors on this diagram.

PAT: 2-sl;13 'PAT - CONTROL ORDER OF EXECUTION OF MODULES IN RUN_GCS'

Input Events:

187 Column 1, 'F' is not a constituent of DDE 'ITH_FRAME_2'.

188 Column 1, DDE 'F' is not a discrete element.

189 Column 1, DDE 'ITH_FRAME_2' is not a discrete element.

190 Column 2, 'F' is not a constituent of DDE 'ITH_FRAME_3'.

191 Column 2, DDE 'F' is not a discrete element.

192 Column 2, DDE 'ITH_FRAME_3' is not a discrete element.

193 Column 3, DDE 'RENDEZVOUS_CNTL' is not a discrete element.

194 Column 4, 'F' is not a constituent of DDE 'END_GCS'.

15 Column 4, DDE 'END_GCS' is not a discrete element.

196 Column 4, DDE 'F' is not a discrete element.

Problem Report Continuation

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a. Report #: Pluto PR #1.0

b. Notes/Explanation (Please reference appropriate section number):

- 197 Column 5, 'F' is not a constituent of DDE 'GP_HAS_RUN'.
- 198 Column 5, DDE 'F' is not a discrete element.
- 199 Column 6, DDE 'SUBFRAME_COUNTER' has a syntax error in its definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: Integer*2;
- 200 Column 6, DDE 'SUBFRAME_COUNTER' is neither control nor data/control.
- Output Events:
- 201 Column 22, DDE 'RUN_DONE' has a syntax error in its definition.
A comment is not terminated on line 6 reading '*':
DATA TYPE: logical*1;
- 202 Column 23, DDE 'RENDEZVOUS_CNTL' is not a discrete element.
- 203 Column 24, 'F' is not a constituent of DDE 'GP_HAS_RUN'.
- 204 Column 24, DDE 'F' is not a discrete element.
- 205 Column 25, DDE 'SUBFRAME_COUNTER' has a syntax error in its definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: Integer*2;
- 206 Column 25, DDE 'SUBFRAME_COUNTER' is neither control nor data/control.
- DFD: 2.1:10 'AECLP - Axial Engine Data Expand and Compress'
- Bubbles:
- 207 Bubble 2 'AECLP-Axial Engine Control Law Processing' does not match the
child P-Spec title 'AECLP-Axial Engine Control Law Processing(P-Spec 2.3.1)'.
- Flows:
- 208 'AE_STATUS' out of child P-Spec 2.1.1 is unmatched.
- 209 'CL' out of bubble 1 is unmatched.
- 210 'GP_ATTITUDE' into child P-Spec 2.1.2 is unmatched.
- 211 'GP_ATTITUDE' out of bubble 1 is unmatched.
- 212 'GRAVITY' out of bubble 1 is unmatched.
- 213 The data flow 'GVI' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: array(1..2) of Real*8;
- No C-Spec balancing errors on this diagram.
No store-to-flow constituent errors on this diagram.
No syntax errors on this diagram.
- P-Spec: 2.1.1:6 'AECLP - Axial Engine Expand Data Flows'
No syntax errors in the I/O list.
- P-Spec: 2.1.2:31 'AECLP - Axial Engine Control Law Processing(P-Spec 2.3.1)'
No syntax errors in the I/O list.
- P-Spec: 2.1.3:3 'AECLP - Axial Engine Compress Data Flows'
No syntax errors in the I/O list.
- DFD: 2.10:5 'TDSP - Touch Down Sensor Processing Data Expand and Compress'
- Bubbles:
- 214 Bubble 1 'TDSP-Touch Down Expand Data Flows' does not match the child P-
Spec title 'TDSP-Touch Down Sensor Processing Expand Data Flows'.

Problem Report Continuation

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Report #: Pluto PR #1.0

Notes/Explanation (Please reference appropriate section number):

- 215 Bubble 2 'TDSP-Touch Down Sensor Processing' does not match the child P-Spec title 'TDSP-Touch Down Sensor Processing(P-SPEC 2.1.6)'.
- 216 Bubble 3 'TDSP-Touch Down Sensor Processing Compress Data Flows' does not match the child P-Spec title 'TDSP-Touch Down Sensor Processing Compress Data Flows'.
- Flows:
- 217 The data flow 'TD_COUNTER' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: integer*2;
- No C-Spec balancing errors on this diagram.
No DFD/P-Spec balancing errors on this diagram.
No store-to-flow constituent errors on this diagram.
No syntax errors on this diagram.
- P-Spec: 2.10.1:7 'TDSP - Touch Down Sensor Processing Expand Data Flows'
No syntax errors in the I/O list.
- P-Spec: 2.10.2:12 'TDSP - Touch Down Sensor Processing(P-SPEC 2.1.6)'
No syntax errors in the I/O list.
- P-Spec: 2.10.3:5 'TDSP - Touch Down Sensor Processing Compress Data Flows'
No syntax errors in the I/O list.
- DFD: 2.11:2 'TSP - Temperature Sensor Processing Data Expand and Compress'
- Bubbles:
- 218 Bubble 2 'TSP-Temperature Sensor Processing' does not match the child P-Spec title 'TSP-Temperature Sensor Processing(P-Spec2.1.5)'.
- Flows:
- 9 'TS_STATUS' into bubble 2 is unmatched.
- 220 The data flow 'SS_TEMP' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE:integer*2;
- 221 The data flow 'THERMO_TEMP' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: integer*2;
- No C-Spec balancing errors on this diagram.
No store-to-flow constituent errors on this diagram.
No syntax errors on this diagram.
- P-Spec: 2.11.1:1 'TSP - Temperature Sensor Processing Data Expand'
No syntax errors in the I/O list.
- P-Spec: 2.11.2:10 'TSP - Temperature Sensor Processing(P-Spec2.1.5)'
No syntax errors in the I/O list.
- P-Spec: 2.11.3:1 'TSP - Temperature Sensor Processing Data Compress'
No syntax errors in the I/O list.
- P-Spec: 2.13:2 'STORE RAW SENSOR DATA'
No syntax errors in the I/O list.
- P-Spec: 2.14:2 'INIT RUN PARM STORE'
No syntax errors in the I/O list.
- P-Spec: 2.15:2 'INIT GUIDANCE STATE STORE'
No syntax errors in the I/O list.
- P-Spec: 2.16:3 'SEND CHUTE RELEASE COMMAND'
- I/O Entries:
- 222 'CHUTE_RELEASE' is an input control flow.

Problem Report Continuation

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a. Report # Pluto PR #1.0

b. Notes/Explanation (Please reference appropriate section number):

P-Spec: 2.17:3 'SEND ENGINE DATA'
No syntax errors in the I/O list.

P-Spec: 2.18:8 'COPY CONTROL DATA'
I/O Entries:

223 'INIT_END_GCS' is an input control flow.

224 'INIT_RENDEZVOUS_CNTL' is an input control flow.

225 'INIT_SUBFRAME_COUNTER' is an input control flow.

226 'RENDEZVOUS_CNTL' is an input control flow.

DFD: 2.2:5 'ARSP - Altimeter Radar Data Expand and Compress'
Bubbles:

227 Bubble 2 'ARSP-Altimeter Radar Sensor Processing' does not match the child P-Spec title 'ARSP-Altimeter Radar Sensor Processing(P-Spec 2.1.2)'.

Flows:

228 'FRAME_COUNTER' into child P-Spec 2.2.2 is unmatched.

229 'FRAME_COUNTER' out of bubble 1 is unmatched.

230 'K_ALT' into child P-Spec 2.2.2 is unmatched.

231 'K_ALT' out of bubble 1 is unmatched.

No C-Spec balancing errors on this diagram.
No DDE errors on this diagram.
No store-to-flow constituent errors on this diagram.
No syntax errors on this diagram.

P-Spec: 2.2.1:3 'ARSP - Altimeter Radar Expand Data Flows'
No syntax errors in the I/O list.

P-Spec: 2.2.2:22 'ARSP - Altimeter Radar Sensor Processing(P-Spec 2.1.2)'
No syntax errors in the I/O list.

P-Spec: 2.2.3:3 'ARSP - Altimeter Radar Compress Data Flows'
No syntax errors in the I/O list.

DFD: 2.3:5 'ASP - Accelerometer Data Expand and Compress'
Bubbles:

232 Bubble 2 'ASP-Accelerometer Sensor Processing' does not match the child P-Spec title 'ASP-Accelerometer Sensor Processing(P-Spec 2.1.1)'.

Flows:

233 'A_ACCELERATION' into child P-Spec 2.3.2 is unmatched.

234 'A_ACCELERATION' into bubble 2 is unmatched.

235 The data flow 'A_COUNTER' has an invalid definition.
A comment is not terminated on line 6 reading '*':
DATA TYPE: array(1..3) of Integer*2;

No C-Spec balancing errors on this diagram.
No store-to-flow constituent errors on this diagram.
No syntax errors on this diagram.

P-Spec: 2.3.1:4 'ASP - Accelerometer Expand Data Flows'
No syntax errors in the I/O list.

P-Spec: 2.3.2:21 'ASP - Accelerometer Sensor Processing(P-Spec 2.1.1)'
No syntax errors in the I/O list.

P-Spec: 2.3.3:3 'ASP - Accelerometer Compress Data Flows'
No syntax errors in the I/O list.

Problem Report Continuation

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Report # **Pluto PR #1.0**

Notes/Explanation (Please reference appropriate section number):

DFD: 2.4.16 'CP - Communications Processing Data Expand and Compress'

Bubbles:

236 Bubble 2 'CP-Communications Processing' does not match the child P-Spec title 'CP-Communications Processing(P-Spec 2.4)'.

Flows:

237 'AE_SWITCH' into bubble 2 is unmatched.

238 'BYTE_PACKET' out of bubble 2 is unmatched.

239 'CHECKSUM' into bubble 2 is unmatched.

240 'CL' from off page to off page is not connected to a bubble or C-Spec connector.

241 'C_STATUS' into bubble 2 is unmatched.

242 'FRAME_BEAM_UNLOCKED' into bubble 2 is unmatched.

243 'FRAME_ENGINES_IGNITED' into bubble 2 is unmatched.

244 'INTERNAL_CMD' into bubble 2 is unmatched.

245 'ITH_FRAME_2' into bubble 2 is unmatched.

246 'ITH_FRAME_5' into bubble 2 is unmatched.

247 'NBYTES' out of bubble 2 is unmatched.

8 'RE_SWITCH' into bubble 2 is unmatched.

249 'TDLRSP_SWITCH' into bubble 2 is unmatched.

250 'TDSP_SWITCH' into bubble 2 is unmatched.

251 'TE_LIMIT' into bubble 2 is unmatched.

252 'THETA' into bubble 2 is unmatched.

253 The control flow 'SUBFRAME_COUNTER' is defined in the Data Dictionary as a data flow.

254 The data flow 'CHECKSUM' has an invalid definition.
A comment is not terminated on line 1 reading '':
* Integer*2 *

No C-Spec balancing errors on this diagram.

No store-to-flow constituent errors on this diagram.

P-Spec: 2.4.1;5 'CP - Communications Processing Expand Data Flows'
No syntax errors in the I/O list.

P-Spec: 2.4.2;25 'CP - Communications Processing(P-Spec 2.4)'
No syntax errors in the I/O list.

P-Spec: 2.4.3;5 'CP - Communications Processing Compress Data Flows'
No syntax errors in the I/O list.

P-Spec: 2.4.4;3 'CP - Communications Processing Expand GUIDANCE_STATE Data Store'
No syntax errors in the I/O list.

P-Spec: 2.4.5;8 'CALCULATE CRC-16'
No syntax errors in the I/O list.

DFD: 2.5;3 'CRCP - Chute Release Control Processing'

Bubbles:

Problem Report Continuation

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a. Report # Pluto PR #1.0

b. Notes/Explanation (Please reference appropriate section number):

255 Bubble 2 'CRCP-Chute Release Control Processing' does not match the child P-Spec title 'CRCP-Chute Release Control Processing(P-Spec 2.3.3)'.

Flows:

256 The control flow 'CHUTE_RELEASED' is defined in the Data Dictionary as a data flow.

No C-Spec balancing errors on this diagram.

No DFD/P-Spec balancing errors on this diagram.

No store-to-flow constituent errors on this diagram.

No syntax errors on this diagram.

P-Spec: 2.5.1:3 'CRCP - Chute Release Expand Data Flows '

No syntax errors in the I/O list.

P-Spec: 2.5.2:10 'CRCP - Chute Release Control Processing(P-Spec 2.3.3)'

I/O Entries:

257 'CHUTE_RELEASED' is an input control flow.

P-Spec: 2.5.3:2 'CRCP - Chute Release Compress Data Flows '

I/O Entries:

258 'CHUTE_RELEASED' is an input control flow.

DFD: 2.6:1 'GSP - Gyroscope Sensor Processing Data Expand and Compress'

Bubbles:

259 Bubble 2 'GSP-Gyroscope Sensor Processing' does not match the child P-Spec title 'GSP-Gyroscope Sensor Processing(P-Spec 2.1.4)'.

Flows:

260 'G_STATUS' into bubble 2 is unmatched.

261 The data flow 'G_COUNTER' has an invalid definition.

A comment is not terminated on line 6 reading '':

DATA TYPE: array(1..3) of Integer*2;

No C-Spec balancing errors on this diagram.

No store-to-flow constituent errors on this diagram.

No syntax errors on this diagram.

P-Spec: 2.6.1:1 'GSP - Gyroscope Sensor Processing Expand Data Flows'

No syntax errors in the I/O list.

P-Spec: 2.6.2:9 'GSP - Gyroscope Sensor Processing(P-Spec 2.1.4)'

No syntax errors in the I/O list.

P-Spec: 2.6.3:1 'GSP - Gyroscope Sensor Processing Compress Data Flows'

No syntax errors in the I/O list.

DFD: 2.7:11 'GP - Guidance Processing Data Expand and Compress'

Bubbles:

262 Bubble 2 'GP-Guidance Processing' does not match the child P-Spec title 'GP-Guidance Processing(P-Spec 2.2)'.

Flows:

263 'CL' from off page to off page is not connected to a bubble or C-Spec connector.

264 'CL' into child P-Spec 2.7.2 is unmatched.

265 'CL' out of child P-Spec 2.7.2 is unmatched.

266 'END_GCS' out of bubble 2 is unmatched.

267 'MAX_NORMAL_VELOCITY' into child P-Spec 2.7.2 is unmatched.

268 'MAX_NORMAL_VELOCITY' out of bubble 1 is unmatched.

Problem Report Continuation

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Report #: Pluto PR #1.0

Notes/Explanation (Please reference appropriate section number):

269 'TE_INTEGRAL' from off page to off page is not connected to a bubble or C-Spec connector.

270 'TE_INTEGRAL' out of child P-Spec 2.7.2 is unmatched.

No C-Spec balancing errors on this diagram.

No DDE errors on this diagram.

No store-to-flow constituent errors on this diagram.

P-Spec: 2.7.1:3 'GP - Guidance Processing Data Expand'
No syntax errors in the I/O list.

P-Spec: 2.7.2:29 'GP - Guidance Processing(P-Spec 2.2)'
No syntax errors in the I/O list.

P-Spec: 2.7.3:4 'GP - Guidance Processing Data Compress'
No syntax errors in the I/O list.

DFD: 2.8:4 'RECLP - Roll Engine Control Law Processing'
Bubbles:

271 Bubble 2 'RECLP-Roll Engine Control Law Processing' does not match the child P-Spec title 'RECLP-Roll Engine Control Law Processing(P-Spec 2.3.2)'.

Flows:

272 'DELTA_T' from off page to off page is not connected to a bubble or C-Spec connector.

273 'DELTA_T' into child P-Spec 2.8.2 is unmatched.

274 'RE_STATUS' into bubble 2 is unmatched.

No C-Spec balancing errors on this diagram.

No DDE errors on this diagram.

No store-to-flow constituent errors on this diagram.

P-Spec: 2.8.1:1 'RECLP - Roll Engine Control Law Processing Data Expand'
No syntax errors in the I/O list.

P-Spec: 2.8.2:13 'RECLP - Roll Engine Control Law Processing(P-Spec 2.3.2)'
No syntax errors in the I/O list.

P-Spec: 2.8.3:1 'RECLP - Roll Engine Control Law Processing Data Compress'
No syntax errors in the I/O list.

DFD: 2.9:4 'TDLRSP - Touch Down Landing Radar Sensor Proc. Data Exp. & Comp.'
Bubbles:

275 Bubble 2 'TDLRSP-Touch Down Landing Radar Sensor Processing' does not match the child P-Spec title 'TDLRSP-Touch Down Landing Radar Sensor Processing(P-Spec 2.1.3)'.

Flows:

276 'TDLR_STATUS' into bubble 2 is unmatched.

277 The data flow 'TDLR_COUNTER' has an invalid definition.
A comment is not terminated on line 5 reading '*':
DATA TYPE: array(1..4) of Integer*2;

No C-Spec balancing errors on this diagram.

No store-to-flow constituent errors on this diagram.

No syntax errors on this diagram.

P-Spec: 2.9.1:4 'TDLRSP - Touch Down Landing Radar Sensor Processing Data Expand'
No syntax errors in the I/O list.

P-Spec: 2.9.2:17 'TDLRSP - Touch Down Landing Radar Sensor Processing(P-Spec 2.1.3)'
No syntax errors in the I/O list.

Problem Report Continuation

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a. Report # **Pluto PR #1.0**

b. Notes/Explanation (Please reference appropriate section number):

P-Spec: 2.9.3:2 'TDLRSP - Touch Down Landing Radar Data Comp'
No syntax errors in the I/O list.

P-Spec: 3:5 'GENERATE_SEQUENCE_PARAMS'
No syntax errors in the I/O list.

Checking completed.

GCS Action Report

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1. AR #: <u>1.1</u> 1.0	2. Planet: Pluto	3. Date of Action: January 10, 1994	4. Respondent & Role: Carter, P. Programmer									
5. Artifact Identification: <table style="width: 100%;"> <tr> <td style="width: 33%;"><input checked="" type="checkbox"/> Design Description</td> <td style="width: 33%;"><input type="checkbox"/> Support Documentation</td> <td style="width: 34%;">Configuration Item:</td> </tr> <tr> <td><input type="checkbox"/> Source Code</td> <td><input type="checkbox"/> Other</td> <td>Pluto Design Description</td> </tr> <tr> <td><input type="checkbox"/> Executable Object Code</td> <td></td> <td></td> </tr> </table>				<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:	<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	Pluto Design Description	<input type="checkbox"/> Executable Object Code		
<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:										
<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	Pluto Design Description										
<input type="checkbox"/> Executable Object Code												
6. Description of Action <div style="margin-left: 20px;"> (*) DFD: Context-Diagram:12 'GCS'. (1) Data Flow "INITIALIZATION_DATA" has an invalid definition. <Action> Removed '+' from 'A_ACCELERATION'. (2) Data Flow "PACKET" has an invalid definition. <Action> Changed '*' to a '-' in data type definition. (*) DFD: 0:17 'INIT_RUN_GCS'. (3) Control Flow "INIT_DONE" has an invalid definition. <Action> Removed ';' from 'INIT_DONE'. (4) Control Flow "RUN_DONE" has an invalid definition. <Action> Changed '*' to a '-' in data type definition. (5) Data Flow "FRAME_COUNTER" has an invalid definition. <Action> Changed '*' to a '-' in data type definition. (*) PAT 0-s1:13 'INIT_RUN_GCS PAT'. (6) DDE "INIT_DONE" has an invalid definition. <Action> Removed ';' from 'INIT_DONE'. (7) DDE "RUN_DONE" has an invalid definition. <Action> Changed '*' to a '-' in data type definition. (*) DFD: 2:51 'RUN_GCS'. (8) Bubble 1 "AECLP" doesn't match child bubble (Axial Engine Data Expand and Compress). <Action> Renamed bubble 1 and child to "AECLP". (9) Bubble 10 "TDSP" doesn't match child bubble (Touch Down Sensor Processing Data Expand and Compress). <Action> Renamed bubble 10 and child to "TDSP". (10) Bubble 11 "TSP" doesn't match child bubble (Temperature Sensor Processing Expand and Compress). <Action> Renamed bubble 11 and child to "TSP". (11) Bubble 2 "ARSP" doesn't match child bubble (Altimeter Radar Data Expand and Compress). <Action> Renamed bubble 2 and child to "ARSP". </div>												
7. Was the action related to another action(s)? <div style="margin-left: 100px;"> <input type="checkbox"/> Yes AR#(s) <input checked="" type="checkbox"/> No <input type="checkbox"/> I don't know </div>												

Action Report Continuation

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a. Report #: 1-8-1.1

b. Notes/Explanation (Please reference appropriate section number):

- (12) Bubble 3 "ASP" doesn't match child bubble (Accelerometer Data Expand and Compress).
<Action> Renamed bubble 3 and child to "ASP".
- (13) Bubble 4 "CP" doesn't match child bubble (Communications Processing Data Expand and Compress).
<Action> Renamed bubble 4 and child to "CP".
- (14) Bubble 6 "GSP" doesn't match child bubble (Gyroscope Sensor Processing Data Expand and Compress).
<Action> Renamed bubble 6 and child to "GSP".
- (15) Bubble 7 "GP" doesn't match child bubble (Guidance Processing Data Expand and Compress).
<Action> Renamed bubble 7 and child to "GP".
- (16) Bubble 8 "RECLP" doesn't match child bubble (Roll Engine Control Law Processing).
<Action> Renamed bubble 8 and child to "RECLP".
- (17) Bubble 9 "TDLRSP" doesn't match child bubble (Touch Down Landing Radar Sensor Proc.Data Exp.&Comp).
<Action> Renamed bubble 9 and child to "TDLRSP".
- (18) P-Spec:2.12 exists, but bubble 12 missing.
<Action> Created bubble 12.
- (19) Data Flow "ACCEL_GS_IN" is not a constituent of store 'GUIDANCE_STATE'.
<Action> Created the Data Store "GUIDANCE_STATE".
- (20) Data Flow "ACCEL_GS_OUT" is not a constituent of store 'GUIDANCE_STATE'.
<Action> Created the Data Store "GUIDANCE_STATE".
- (21) Data Flow "ACCEL_RP_IN" is not a constituent of store 'RUN_PARAMETERS'.
<Action> Created the Data Store "RUN_PARAMETERS".
- (22) Data Flow "ACCEL_SO_IN" is not a constituent of store 'SENSOR_OUTPUT'.
<Action> Created the Data Store "SENSOR_OUTPUT".
- (23) Data Flow "ACCEL_SO_OUT" is not a constituent of the store 'SENSOR_OUTPUT'.
<Action> Created the Data Store "SENSOR_OUTPUT".

Action Report Continuation

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a. Report #: 1011

b. Notes/Explanation (Please reference appropriate section number):

- (24) DDE "AE_CMD" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (25) DDE "AE_STATUS" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (26) DDE "AE_SWITCH" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (27) DDE "AE_TEMP" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (28) DDE "ALPHA_MATRIX" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (29) Data Flow "ALT_RAD_GS_IN" is not a constituent of the store 'GUIDANCE_STATE'.
<Action> Created the Data Store "GUIDANCE_STATE".
- (30) Data Flow "ALT_RAD_GS_OUT" is not a constituent of the store 'GUIDANCE_STATE'.
<Action> Created the Data Store "GUIDANCE_STATE".
- (31) Data Flow "ALT_RAD_RP_IN" is not a constituent of the store 'RUN_PARAMETERS'.
<Action> Created the Data Store "RUN_PARAMETERS".
- (32) Data Flow "ALT_RAD_SO_IN" is not a constituent of the store 'SENSOR_OUTPUT'.
<Action> Created the Data Store "SENSOR_OUTPUT".
- (33) Data Flow "ALT_RAD_SO_OUT" is not a constituent of the store 'SENSOR_OUTPUT'.
<Action> Created the Data Store "SENSOR_OUTPUT".
- (34) DDE "AR_ALTITUDE" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (35) DDE "AR_COUNTER" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (36) DDE "AR_FREQUENCY" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (37) DDE "AR_STATUS" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (38) DDE "ATMOSPHEREIC_TEMP" is undefined.
<Action> Corrected misspelling of 'ATMOSPHERIC_TEMP'.

Action Report Continuation

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a. Report #: 1.0 1.1

b. Notes/Explanation (Please reference appropriate section number):

- (39) DDE "ATMOSPHERIC_TEMP" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (40) Data Flow "AX_ENG_GS_IN" is not a constituent of the store 'GUIDANCE_STATE'.
<Action> Created the Data Store "GUIDANCE_STATE".
- (41) Data Flow "AX_ENG_GS_OUT" is not a constituent of the store 'GUIDANCE_STATE'.
<Action> Created the Data Store "GUIDANCE_STATE".
- (42) Data Flow "AX_ENG_RP_IN" is not a constituent of the store 'RUN_PARAMETERS'.
<Action> Created the Data Store "RUN_PARAMETERS".
- (43) Data Flow "AX_ENG_SO_IN" is not a constituent of the store 'SENSOR_OUTPUT'.
<Action> Created the Data Store "SENSOR_OUTPUT".
- (44) DDE "A_ACCELERATION" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (45) DDE "A_BIAS" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (46) DDE "A_GAIN" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (47) DDE "A_SCALE" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (48) DDE "A_STATUS" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (49) Control Flow "CHUTE_RELEASE" is not a constituent of the store 'GUIDANCE_STATE'.
<Action> Created the Data Store "GUIDANCE_STATE".
- (50) DDE "CHUTE_RELEASED" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (51) Data Flow "CHUTE_REL_GS_IN" is not a constituent of the store 'GUIDANCE_STATE'.
<Action> Created the Data Store "GUIDANCE_STATE".

a. Report #: 1011

b. Notes/Explanation (Please reference appropriate section number):

- (52) Data Flow "CHUTE_REL_GS_OUT" is not a constituent of the store 'GUIDANCE_STATE'.
 <Action> Created the Data Store "GUIDANCE_STATE".
- (53) DDE "CL" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (54) Data Flow "CL" is unmatched out of DFD 2.4.
 <Action> Added 'CL' to the output list of P-Spec 2.4.4.
- (55) Data Flow "CL" is unmatched out of DFD 2.7.
 <Action> Added 'CL' to the output list of P-Spec 2.7.1.
- (56) Data Flow "COMM_GS_IN" is not a constituent of the store 'GUIDANCE_STATE'.
 <Action> Created the Data Store "GUIDANCE_STATE".
- (57) Data Flow "COMM_GS_OUT" is not a constituent of the store 'GUIDANCE_STATE'.
 <Action> Created the Data Store "GUIDANCE_STATE".
- (58) Data Flow "COMM_RP_IN" is not a constituent of the store 'RUN_PARAMETERS'.
 <Action> Created the Data Store "RUN_PARAMETERS".
- (59) Data Flow "COMM_SO_IN" is not a constituent of the store 'SENSOR_OUTPUT'.
 <Action> Created the Data Store "SENSOR_OUTPUT".
- (60) DDE "COMM_SYNC_PATTERN" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (61) DDE "CONTOUR_ALTITUDE" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (62) DDE "CONTOUR_CROSSED" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (63) DDE "CONTOUR_VELOCITY" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (64) DDE "C_STATUS" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (65) DDE "DELTA_T" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (66) Data Flow "DELTA_T" is unmatched out of DFD 2.8.
 <Action> Added 'DELTA_T' to the output list of P-Spec 2.8.1.

Action Report Continuation

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a. Report #: 10-11

b. Notes/Explanation (Please reference appropriate section number):

- (67) DDE "DROP_HEIGHT" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (68) DDE "DROP_SPEED" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (69) "ENGINES_OFF" is undefined.
 <Action> Unnecessary variable deleted from file.
- (70) DDE "ENGINES_ON_ALTITUDE" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (71) DDE "FRAME_BEAM_UNLOCKED" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (72) Data Flow "FRAME_COUNTER" is unmatched out of DFD 2.2.
 <Action> Added 'FRAME_COUNTER' to the output list of P-Spec 2.2.1.
- (73) DDE "FRAME_ENGINES_IGNITED" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (74) DDE "FULL_UP_TIME" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (75) DDE "GA" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (76) DDE "GAX" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (77) DDE "GPY" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (78) DDE "GP1" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (79) DDE "GP2" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (80) DDE "GP_ALTITUDE" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (81) DDE "GP_ATTITUDE" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (82) Data Flow "GP_ATTITUDE" is unmatched out of DFD 2.1.
 <Action> Added "GP_ATTITUDE" to the output list of P-Spec 2.1.1.
- (83) DDE "GP_PHASE" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (84) DDE "GP_ROTATION" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.

a. Report #: 1-011

b. Notes/Explanation (Please reference appropriate section number):

- (85) DDE "GP_VELOCITY" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (86) DDE "GQ" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (87) DDE "GR" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (88) DDE "GRAVITY" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (89) Data Flow "GUIDE_GS_IN" is not a constituent of the store
 'GUIDANCE_STATE'.
 <Action> Created the Data Store "GUIDANCE_STATE".
- (90) Data Flow "GUIDE_GS_OUT" is not a constituent of the store
 'GUIDANCE_STATE'.
 <Action> Created the Data Store "GUIDANCE_STATE".
- (91) Data Flow "GUIDE_RP_IN" is not a constituent of the store
 'RUN_PARAMETERS'.
 <Action> Created the Data Store "RUN_PARAMETERS".
- (92) Data Flow "GUIDE_SO_IN" is not a constituent of the store
 'SENSOR_OUTPUT'.
 <Action> Created the Data Store "SENSOR_OUTPUT".
- (93) DDE "GV" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (94) DDE "GVE" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (95) DDE "GVEI" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (96) DDE "GW" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (97) DDE "GWI" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (98) Data Flow "GYRO_GS_IN" is not a constituent of the store
 'GUIDANCE_STATE'.
 <Action> Created the Data Store "GUIDANCE_STATE".

Action Report Continuation

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a. Report #: 1011

b. Notes/Explanation (Please reference appropriate section number):

- (99) Data Flow "GYRO_GS_OUT" is not a constituent of the store 'GUIDANCE_STATE'.
<Action> Created the Data Store "GUIDANCE_STATE".
- (100) Data Flow "GYRO_RP_IN" is not a constituent of the store 'RUN_PARAMETERS'.
<Action> Created the Data Store "RUN_PARAMETERS".
- (101) Data Flow "GYRO_SO_IN" is not a constituent of the store 'SENSOR_OUTPUT'.
<Action> Created the Data Store "SENSOR_OUTPUT".
- (102) Data Flow "GYRO_SO_OUT" is not a constituent of the store 'SENSOR_OUTPUT'.
<Action> Created the Data Store "SENSOR_OUTPUT".
- (103) DDE "G1" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (104) DDE "G2" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (105) DDE "G3" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (106) DDE "G4" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (107) DDE "G_GAIN_0" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (108) DDE "G_OFFSET" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (109) DDE "G_ROTATION" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (110) DDE "G_STATUS" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (111) Data Flow "INIT_GS_OUT" is not a constituent of the store 'GUIDANCE_STATE'.
<Action> Created the Data Store "GUIDANCE_STATE".
- (112) Data Flow "INIT_RP_OUT" is not a constituent of the store 'RUN_PARAMETERS'.
<Action> Created the Data Store "RUN_PARAMETERS".

Action Report Continuation

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a. Report #: 10-11

b. Notes/Explanation (Please reference appropriate section number):

- (113) DDE "INTERNAL_CMD" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (114) DDE "K_ALT" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (115) DDE "K_MATRIX" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (116) DDE "MAX_NORMAL_VELOCITY" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (117) Data Flow "MAX_NORMAL_VELOCITY" is unmatched out of DFD 2.7.
<Action> Added 'MAX_NORMAL_VELOCITY' to the output list of P-Spec 2.7.1.
- (118) DDE "M1" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (119) DDE "M2" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (120) DDE "M3" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (121) DDE "M4" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (122) DDE "OMEGA" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (123) DDE "PE_INTEGRAL" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (124) DDE "PE_MAX" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (125) DDE "PE_MIN" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (126) DDE "P1" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (127) DDE "P2" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (128) DDE "P3" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (129) DDE "P4" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (130) DDE "RE_CMD" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (131) DDE "RE_STATUS" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (132) DDE "RE_SWITCH" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.

Action Report Continuation

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a. Report #: 1011

b. Notes/Explanation (Please reference appropriate section number):

- (133) Data Flow "ROL_ENG_GS_IN" is not a constituent of the store 'GUIDANCE_STATE'.
<Action> Created the Data Store GUIDANCE_STATE".
- (134) Data Flow "ROL_ENG_GS_OUT" is not a constituent of the store 'GUIDANCE_STATE'.
<Action> Created the Data Store "GUIDANCE_STATE".
- (135) Data Flow "ROL_ENG_RP_IN" is not a constituent of the store 'RUN_PARAMETERS'.
<Action> Created the Data Store "RUN_PARAMETERS".
- (136) Data Flow "ROL_ENG_SO_IN" is not a constituent of the store 'SENSOR_OUTPUT'.
<Action> Created the Data Store "SENSOR_OUTPUT".
- (137) DDE "TDLRSP_SWITCH" is undefined.
<Action> Defined this variable in the Data Dictionary.
- (138) DDE "TDLR_ANGLES" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (139) DDE "TDLR_GAIN" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (140) DDE "TDLR_LOCK_TIME" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (141) DDE "TDLR_OFFSET" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (142) DDE "TDLR_STATE" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (143) DDE "TDLR_STATUS" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (144) DDE "TDLR_VELOCITY" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (145) DDE "TDSP_SWITCH" is undefined.
<Action> Defined the variable in the Data Dictionary.
- (146) DDE "TDS_STATUS" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (147) Data Flow "TD_GS_IN" is not a constituent of the store 'GUIDANCE_STATE'.
<Action> Created the Data Store "GUIDANCE_STATE".

Action Report Continuation

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a. Report #: 1011

b. Notes/Explanation (Please reference appropriate section number):

- (148) Data Flow "TD_GS_OUT" is not a constituent of the store 'GUIDANCE_STATE'.
<Action> Created the Data Store "GUIDANCE_STATE".
- (149) Data Flow "TD_LND_RAD_GS_IN" is not a constituent of the store 'GUIDANCE_STATE'.
<Action> Created the Data Store "GUIDANCE_STATE".
- (150) Data Flow "TD_LND_RAD_GS_OUT" is not a constituent of the store 'GUIDANCE_STATE'.
<Action> Created the Data Store "GUIDANCE_STATE".
- (151) Data Flow "TD_LND_RAD_RP_IN" is not a constituent of the store 'RUN_PARAMETERS'.
<Action> Created the Data Store "RUN_PARAMETERS".
- (152) Data Flow "TD_LND_RAD_SO_IN" is not a constituent of the store 'SENSOR_OUTPUT'.
<Action> Created the Data Store "SENSOR_OUTPUT".
- (153) Data Flow "TD_LND_RAD_SO_OUT" is not a constituent of the store 'SENSOR_OUTPUT'.
<Action> Created the Data Store "SENSOR_OUTPUT".
- (154) DDE "TD_SENSED" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (155) Data Flow "TD_SO_OUT" is not a constituent of the store 'SENSOR_OUTPUT'.
<Action> Created the Data Store "SENSOR_OUTPUT".
- (156) Data Flow "TEMP_GS_IN" is not a constituent of the store 'GUIDANCE_STATE'.
<Action> Created the Data store "GUIDANCE_STATE".
- (157) Data Flow "TEMP_GS_OUT" is not a constituent of the store 'GUIDANCE_STATE'.
<Action> Created the Data Store "GUIDANCE_STATE".

a. Report #: 1.0 1.1

b. Notes/Explanation (Please reference appropriate section number):

- (158) Data Flow "TEMP_RP_IN" is not a constituent of the store 'RUN_PARAMETERS'.
 <Action> Created the Data Store "RUN_PARAMETERS".
- (159) Data Flow "TEMP_SO_OUT" is not a constituent of the store 'SENSOR_OUTPUT'.
 <Action> Created the Data Store "SENSOR_OUTPUT".
- (160) DDE "TE_DROP" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (161) DDE "TE_INIT" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (162) DDE "TE_INTEGRAL" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (163) Data Flow "TE_INTEGRAL" is unmatched out of DFD 2.7.
 <Action> Added 'TE_INTEGRAL' to the input list of P-Spec 2.7.3.
- (164) DDE "TE_LIMIT" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (165) DDE "TE_MAX" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (166) DDE "TE_MIN" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (167) DDE "THETA" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (168) DDE "THETA1" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (169) DDE "THETA2" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (170) DDE "TS_STATUS" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (171) DDE "T1" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (172) DDE "T2" has an invalid definition.
 <Action> Change '*' to a '-' in data type definition.
- (173) DDE "T3" has invalid definition.
 <Action> Changed '*' to a '-' in data type definition.

Action Report Continuation

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1. Report #: 1011

b. Notes/Explanation (Please reference appropriate section number):

- (174) DDE "T4" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (175) DDE "VELOCITY_ERROR" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (176) DDE "YE_INTEGRAL" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (177) DDE "YE_MAX" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (178) DDE "YE_MIN" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (179) DDE "SUBFRAME_COUNTER" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (180) Control Flow "SUBFRAME_COUNTER" defined as a data flow.
<Action> Changed 'SUBFRAME_COUNTER' to a control flow in DD.
- (181) Store "GUIDANCE_STATE" defined as a flow.
<Action> Created the Data Store "GUIDANCE_STATE".
- (182) Store "GUIDANCE_STATE" is undefined.
<Action> Created the Data Store "GUIDANCE_STATE".
- (183) Store "RUN_PARAMETERS" defined as a flow.
<Action> Created the Data Store "RUN_PARAMETERS".
- (184) Store "RUN_PARAMETERS" is undefined.
<Action> Created the Data Store "RUN_PARAMETERS".
- (185) Store "SENSOR_OUTPUT" is defined as a flow.
<Action> Created the Data Store "SENSOR_OUTPUT".
- (186) Store "SENSOR_OUTPUT" is undefined.
<Action> Created the Data Store "SENSOR_OUTPUT".
- (*) PAT 2-s1:13 'PAT - CONTROL ORDER OF EXECUTION OF MODULES IN RUN_GCS'
- (187) Column 1, "F" 'Not a constituent of DDE "ITH_FRAME_2"'.
<Action> Renamed 'F' to 'FALSE' in PAT.
- (188) Column 1, DDE 'F' is not a discrete element.
<Action> Renamed 'F' to 'FALSE' in PAT.
- (189) Column 1, DDE "ITH_FRAME_2" is not a discrete element.
<Action> Modified the data element type attribute to "discrete".
- (190) Column 2, "F" 'Not a constituent of DDE "ITH_FRAME_5"'.
<Action> Renamed 'F' to 'FALSE' in PAT.

PAT

Action Report Continuation

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a. Report #: 1-01.1

b. Notes/Explanation (Please reference appropriate section number):

- (191) Column 2, DDE "F" is not a discrete element.
<Action> Deleted this entry in the Data Dictionary.
- (192) Column 2, DDE "ITH_FRAME_5" is not a discrete element.
<Action> Modified the data element type attribute to "discrete".
- (193) Column 3, DDE "RENDEZVOUS_CNTL" is not a discrete element.
<Action> Modified the data element type attribute to "discrete".
- (194) Column 4, "F" is not a constituent of DDE 'END_GCS'.
<Action> Renamed 'F' to 'FALSE' in pat. PAT
- (195) Column 4, DDE "END_GCS" is not a discrete element.
<Action> Modified the data element type attribute to "discrete".
- (196) Column 4, DDE "F" is not a discrete element.
<Action> Deleted this entry in the Data Dictionary.
- (197) Column 5, "F" is not a constituent of DDE 'GP_HAS_RUN'.
<Action> Renamed 'F' to 'FALSE' in pat. PAT
- (198) Column 5, DDE "F" is not a discrete element.
<Action> Deleted this entry in the Data Dictionary.
- (199) DDE "SUBFRAME_COUNTER" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (200) DDE 'SUBFRAME_COUNTER' is neither control or data flow.
<Action> Made 'SUBFRAME_COUNTER' a control flow in DD.
- (201) DDE "RUN_DONE" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (202) Column 23, DDE "RENDEZVOUS_CNTL" is not a discrete element.
<Action> Modified the data element type attribute to "discrete".
- (203) Column 24, "F" is not a constituent of DDE 'GP_HAS_RUN'.
<Action> Renamed 'F' to 'FALSE' in pat. PAT
- (204) Column 24, DDE "F" is not a discrete element.
<Action> Renamed 'F' to 'FALSE' in pat. PAT
- (205) DDE "SUBFRAME_COUNTER" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (206) DDE "SUBFRAME_COUNTER" is neither control or data flow.
<Action> Made 'SUBFRAME_COUNTER' a control flow in DD.
- (*) DFD 2.1:10 'AECLP'.
- (207) DFD 2.1 bubble 2 (Axial Engine Control Law Processing) doesn't match P-Spec 2.1.2 title. AECLP -
<Action> Modified P-Spec 2.1.2 title to (Axial Engine Control Law Processing).

Action Report Continuation

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a. Report #: 1-01.1

b. Notes/Explanation (Please reference appropriate section number):

- (208) Data Flow "AE_STATUS" is unmatched out of P-Spec 2.1.1.
<Action> Added 'AE_STATUS' to the input list of P-Spec 2.1.2.
- (209) Data Flow "CL" out of DFD 2.1 bubble 1 is unmatched.
<Action> Modified DFD 2.1 redrawing the data flow CL between DFD 2.1.1 and DFD 2.2.2.
- (210) Data Flow "GP_ATTITUDE" INTO P-Spec 2.1.2 is unmatched.
<Action> Modified DFD 2.1 redrawing the data flow GP_ATTITUDE between 2.1.1 AND 2.1.2.
- (211) Data Flow "GP_ATTITUDE" out of DFD 2.1 bubble 1 is unmatched.
<Action> Modified DFD 2.1 redrawing the data flow GP_ATTITUDE between DFD 2.1 bubble 1 and DFD 2.1 bubble 2.
- (212) Data Flow "GRAVITY" out of DFD 2.1 bubble 1 is unmatched.
<Action> Added 'GRAVITY' to the output list of P-Spec 2.1.1.
- (213) DDE "GVI" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (*) DFD 2.10:5 'TDSP'. TDSP -
- (214) DFD 2.10 bubble 1 (Touch Down Expand Data Flows) doesn't match P-Spec 2.10.1 title.
<Action> Modified P-Spec 2.10.1 title to (Touch Down Expand Data Flows).
- (215) DFD 2.10 bubble 2 (Touch Down Sensor Processing) doesn't match P-Spec 2.10.2 title.
<Action> Modified P-Spec 2.10.2 title to TDSP - (Touch Down Sensor Processing).
- (216) DFD 2.10 bubble 3 (Touch Down Compress Data Flows) doesn't match P-Spec 2.10.3 title.
<Action> Modified P-Spec 2.10.3 title to TDSP - (Touch Down Compress Data Flows).
- (217) DDE "TD_COUNTER" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (*) DFD 2.11:2 'TSP'. TSP -
- (218) DFD 2.11 bubble 2 (Temperature Sensor Processing) doesn't match P-Spec 2.11.2 title.
<Action> Modified P-Spec 2.11.2 title to TSP - (Temperature Sensor Processing).
- (219) Data Flow "TS_STATUS" is unmatched into DFD 2.11.
<Action> Added 'TS_STATUS' to the input list of P-Spec 2.11.1.
- (220) DDE "SS_TEMP" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (221) DDE "THERMO_TEMP" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.

Action Report Continuation

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a. Report #: 1011

b. Notes/Explanation (Please reference appropriate section number):

- (*) P-Spec 2.16;3 "SEND CHUTE RELEASE COMMAND".
(222) DDE "CHUTE_RELEASE" is an input control flow.
<Action> Changed 'CHUTE_RELEASE' to a data flow.
- (*) P-Spec 2.18;8 "COPY CONTROL DATA".
(223) I/O Entry: "INIT_END_GCS" is an input control flow.
<Action> Changed 'INIT_END_GCS' to a data flow.
(224) I/O Entry: "INIT_RENDEZVOUS_CNTL" is an input control flow.
<Action> Changed 'INIT_RENDEZVOUS_CNTL' to a data flow.
(225) I/O Entry: "INIT_SUBFRAME_COUNTER" is an input control flow.
<Action> Changed 'INIT_SUBFRAME_COUNTER' to a data flow.
(226) I/O Entry: "RENDEZVOUS_CNTL" is an input control flow.
<Action> Changed 'RENDEZVOUS_CNTL' to a data flow.
- (*) DFD 2.2;5 'ARSP'.
(227) DFD 2.2 bubble 2 (Altimeter Radar Sensor Processing) doesn't match P-Spec 2.2.2 title. *ARSP -*
<Action> Modified P-Spec 2.2.2 title to (Altimeter Radar Sensor Processing).
(228) Data Flow "FRAME_COUNTER" into child P-Spec 2.2.2 is unmatched.
<Action> Added 'FRAME_COUNTER' to the output list of the P-Spec 2.2.1.
(229) Data Flow "FRAME_COUNTER" is unmatched out of DFD 2.2 bubble 1.
<Action> Added 'FRAME_COUNTER' to the P-Spec 2.2.1 output list.
(230) Data Flow "K_ALT" into child P-Spec 2.2.2 is unmatched.
<Action> Added 'K_ALT' to the output list of the P-Spec 2.2.1.
(231) Data Flow "K_ALT" is unmatched out of DFD 2.2 bubble 1.
<Action> Added 'K_ALT' to the P-Spec 2.2.1 output list.
- (*) DFD 2.3;5 'ASP'.
(232) DFD 2.3 bubble 2 (Accelerometer Sensor Processing) doesn't match P-Spec 2.3.2 title. *ASP -*
<Action> Modified P-Spec 2.3.2 title to (Accelerometer Sensor Processing).
(233) Data Flow "A_ACCELERATION" into child P-Spec 2.3.2 is unmatched.
<Action> Added 'A_ACCELERATION' to the input list of the P-Spec.
(234) Data Flow "A_ACCELERATION" is unmatched into DFD 2.3 bubble 2.
<Action> Added 'A_ACCELERATION' to input list of P-Spec 2.3.2.
(235) DDE "A_COUNTER" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.
- (*) DFD 2.4;16 'CP'.
(236) DFD 2.4 bubble 2 (Communications Processing) doesn't match P-Spec 2.4.2 title. *CP -*
<Action> Modified P-Spec 2.4.2 title to (Communications Processing).

a. Report #: 1011

b. Notes/Explanation (Please reference appropriate section number):

(*) DFD 2.4 'CP'.

(237) Data Flow "AE_SWITCH" is unmatched into DFD 2.4 bubble 2.

<Action> Added 'AE_SWITCH' to the input list of P-Spec 2.4.2.

(238) Data Flow "BYTE_PACKET" is unmatched out of DFD 2.4 bubble 2.

<Action> Added 'BYTE_PACKET' to the output list of P-Spec 2.4.2.

(239) Data Flow "CHECKSUM" is unmatched into DFD 2.4 bubble 2.

<Action> Added 'CHECKSUM' to the input list of P-Spec 2.4.2.

(240) Data Flow "CL" not connected to a bubble or C-Spec connector.

<Action> Redrew the flow so it connected DFD 2.4 bubble 2 and DFD 2.4 bubble 4.

(241) Data Flow "C_STATUS" is unmatched into DFD 2.4 bubble 2.

<Action> Added 'C_STATUS' to the input list of P-Spec 2.4.2.

(242) Data Flow "FRAME_BEAM_UNLOCKED" is unmatched into DFD 2.4 bubble 2.

<Action> Added 'FRAME_BEAM_UNLOCKED' to the input list of P-Spec 2.4.2.

(243) Data Flow "FRAME_ENGINES_IGNITED" is unmatched into DFD 2.4 bubble 2.

<Action> Added 'FRAME_ENGINES_IGNITED' to the input list of P-Spec 2.4.2.

(244) Data Flow "INTERNAL_CMD" is unmatched into DFD 2.4 bubble 2.

<Action> Added 'INTERNAL_CMD' to the input list of P-Spec 2.4.2.

(245) Data Flow "ITH_FRAME_2" is unmatched into DFD 2.4 bubble 2.

<Action> Added 'ITH_FRAME_2' to the input list of P-Spec 2.4.2.

(246) Data Flow "ITH_FRAME_5" is unmatched into DFD 2.4 bubble 2.

<Action> Added 'ITH_FRAME_5' to the input list of P-Spec 2.4.2.

(247) Data Flow "NBYTES" is unmatched out of DFD 2.4 bubble 2.

<Action> Added 'NBYTES' to the output list of P-Spec 2.4.2.

(248) Data Flow "RE_SWITCH" is unmatched into DFD 2.4 bubble 2.

<Action> Added 'RE_SWITCH' to the input list of P-Spec 2.4.2.

(249) Data Flow "TDLRSP_SWITCH" is unmatched into DFD 2.4 bubble 2.

<Action> Added 'TDLRSP_SWITCH' to the input list of P-Spec 2.4.2.

(250) Data Flow "TDSP_SWITCH" is unmatched into DFD 2.4 bubble 2.

<Action> Added 'TDSP_SWITCH' to the input list of P-Spec 2.4.2.

(251) Data Flow "TE_LIMIT" is unmatched into DFD 2.4 bubble 2.

<Action> Added 'TE_LIMIT' to the input list of P-Spec 2.4.2.

(252) Data Flow "THETA" is unmatched into DFD 2.4 bubble 2.

<Action> Added 'THETA' to the input list of P-Spec 2.4.2.

(253) Control Flow "SUBFRAME_COUNTER" is defined as a data flow.

<Action> Changed 'SUBFRAME_COUNTER' to a control flow in DD.

(254) DDE "CHECKSUM" has an invalid definition.

<Action> Changed '*' to a '-' in data type definition.

a. Report #: 1-0 1.1

o. Notes/Explanation (Please reference appropriate section number):

- (*) DFD 2.3 'CRCP'.
 (255) DFD 2.3 bubble 2 (Chute Release Control Processing) doesn't match P-Spec 2.3.2 title.
 <Action> Modified P-Spec 2.3.2 title to (Chute Release Control Processing).
- (*) P-Spec 2.5.1;3 "CRCP".
 (256) Control Flow "CHUTE_RELEASED" is defined as a data flow.
 <Action> Changed 'CHUTE_RELEASED' to a control flow in the DD.
- (*) P-Spec 2.5.2;10 "CRCP".
 (257) I/O Entry: "CHUTE_RELEASED" is an input control flow.
 <Action> Changed 'CHUTE_RELEASE' to a data flow.
- (*) P-Spec 2.5.3;2 "CRCP".
 (258) I/O Entry: "CHUTE_RELEASED" is an input control flow.
 <Action> Changed 'CHUTE_RELEASED' to a data flow.
- (*) DFD 2.6;1 'GSP'.
 (259) DFD 2.6 bubble 2 (Gyroscope Sensor Processing) doesn't match P-Spec 2.6.2 title.
 <Action> Modified P-Spec 2.6.2 title to (Gyroscope Sensor Processing).
- (260) Data Flow "G_STATUS" is unmatched into DFD 2.6 bubble 2.
 <Action> Added 'G_STATUS' to the input list of P-Spec 2.6.2.
- (261) DDE "G_COUNTER" has an invalid definition.
 <Action> Changed '*' to a '-' in data type definition.
- (*) DFD 2.7;11 "GP".
 (262) DFD 2.7 bubble 2 (Guidance Processing) doesn't match P-Spec 2.7.2 title.
 <Action> Modified P-Spec 2.7.2 title to (Guidance Processing).
- (263) Data Flow "CL" not connected to a bubble or C-Spec connector.
 <Action> Redrew the flow so it connected both DFD 2.7 bubble 1 and DFD 2.7 bubble 2.
- (264) Data Flow "CL" is unmatched into P-Spec 2.7.2.
 <Action> Added 'CL' to the input list of P-Spec 2.7.2.
- (265) Data Flow "CL" is unmatched out of P-Spec 2.7.2.
 <Action> Added 'CL' to the output list of P-Spec 2.7.2.
- (266) Data Flow "END_GCS" is unmatched out of DFD 2.7 bubble 2.
 <Action> Added 'END_GCS' to the output list of P-Spec 2.7.2.
- (267) Data Flow "MAX_NORMAL_VELOCITY" is unmatched in child P-Spec 2.7.2.
 <Action> Added 'MAX_NORMAL_VELOCITY' to the input list of P-Spec 2.7.2.

Action Report Continuation

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a. Report #: 1011

b. Notes/Explanation (Please reference appropriate section number):

- (268) Data Flow "MAX_NORMAL_VELOCITY" is unmatched out of DFD 2.7 bubble 1.
<Action> Added 'MAX_NORMAL_VELOCITY' to the output list of P-Spec 2.7.1.
- (269) Data Flow "TE_INTEGRAL" not connected to a bubble or 'C-Spec.
<Action> Redrew the flow so it connected both DFD 2.7 bubble 1 and DFD 2.7 bubble 2.
- (270) Data Flow "TE_INTEGRAL" is unmatched out of P-Spec 2.7.2.
<Action> Added 'TE_INTEGRAL' to the output list of P-Spec 2.7.2.
- (*) DFD 2.8;4 'RECLP'.
- (271) DFD 2.8 bubble 2 (Roll Engine Control Law Processing) doesn't match P-Spec 2.8.2 title.
<Action> Modified P-Spec 2.8.2 title to ^{RECLP -} (Roll Engine Control Law Processing).
- (272) Data Flow "DELTA_T" not connected to a bubble or C-Spec.
<Action> Redrew the flow so it connected both DFD 2.8 bubble 1 and DFD 2.8 bubble 2.
- (273) Data Flow "DELTA_T" is unmatched into P-Spec 2.8.2.
<Action> Added 'DELTA_T' to the input list of P-Spec 2.8.2.
- (274) Data Flow "RE_STATUS" is unmatched into DFD 2.8 bubble 2.
<Action> Added 'RE_STATUS' to the input list of P-Spec 2.8.2.
- (*) DFD 2.9;4 'TDLRSP'.
- (275) DFD 2.9 bubble 2 (Touch Down Landing Radar Sensor Processing) doesn't match P-Spec 2.9.2 title.
<Action> Modified P-Spec 2.9.2 title to ^{TDLR -} (Touch Down Landing Radar Sensor Processing).
- (276) Data Flow "TDLR_STATUS" is unmatched into DFD 2.9 bubble 2.
<Action> Added 'TDLR_STATUS' to the input list of P-Spec 2.9.2.
- (277) DDE "TDLR_COUNTER" has an invalid definition.
<Action> Changed '*' to a '-' in data type definition.

GCS Problem Report

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1. PR #: 2.0	2. Planet: PLUTO	3. Discovery Date: Oct 15, 1993	4. Initiator & Role: Inspectors / Angellatta and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design	X									
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

There are several bubbles in the design which have no purpose. Because the P-Specs for these bubbles do not specify any processing the bubbles are extraneous to the design. The bubbles are identified below.

- 2.1.1 AECLP - Axial Engine Expand Data Flows
- 2.1.3 AECLP - Axial Engine Compress Data Flows
- 2.2.1 ARSP - Altimeter Radar Data Expand Data Flows
- 2.2.3 ARSP - Altimeter Radar Data Compress Data Flows
- 2.3.1 ASP - Accelerometer Expand Data Flows
- 2.3.3 ASP - Accelerometer Compress Data Flows
- 2.4.1 CP - Communications Processing Expand Data Flows
- 2.4.3 CP - Communications Processing Compress Data Flows
- 2.4.4 CP - Communications Processing Expand GUIDANCE_STATE Data Store
- 2.5.1 CRCP - Chute Release Expand Data Flows
- 2.5.3 CRCP - Chute Release Compress Data Flows

7. Artifact Identification:

<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:
<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	Pluto Design Description
<input type="checkbox"/> Executable Object Code		

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
1/21/94	1/31/94	W. J. C. De. Dig		2.1
2/1/94	2/11/94	Rob Angellatta		
2/11/94	2/15/94	G. Finelli SQA		

10. Total # of Changes: 23

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by
Rob Angellatta

Feb 11, 1994

13. SQA Signature & Date

Original Signed by
George Finelli

2/16/94

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 2

a. Report #: **Pluto PR #2.0**

b. Notes/Explanation (Please reference appropriate section number):

- 2.6.1 GSP - Gyroscope Sensor Processing Expand Data Flows
- 2.6.3 GSP - Gyroscope Sensor Processing Compress Data Flows
- 2.7.1 GP - Guidance Processing Data Expand
- 2.7.3 GP - Guidance Processing Data Compress
- 2.8.1 RECLP - Roll Engine Control Law Processing Data Expand
- 2.8.3 RECLP - Roll Engine Control Law Processing Data Compress
- 2.9.1 TDLRSP - Touch Down Landing Radar Sensor Processing Data Expand
- 2.9.3 TDLRSP - Touch Down Landing Radar Sensor Processing Data Compress
- 2.10.1 TDSP - Touch Down Expand Data Flows
- 2.10.3 TDSP - Touch Down Compress Data Flows
- 2.11.1 TSP - Temperature Sensor Processing Data Expand
- 2.11.3 TSP - Temperature Sensor Processing Data Compress

GCS Action Report

page 1 of 6

1. AR #; 2.01	2. Planet: Pluto	3. Date of Action: February 9, 1994	4. Respondent & Role: Carter, P. Programmer
5. Artifact Identification: <input checked="" type="checkbox"/> Design Description <input type="checkbox"/> Support Documentation Configuration Item: <input type="checkbox"/> Source Code <input type="checkbox"/> Other <input type="checkbox"/> Executable Object Code			
Pluto Design Description			
6. Description of Action (***) DFD 2 'RUN_GCS'. (*) DFD 2.1 "AECLP". (1) DFD 2.1 "AECLP" is an unnecessary level of complexity in the model design. <Action> Deleted DFD 2.1 "AECLP" from the model. Retitled "AECLP" to "AECLP - Axial Engine Control Law Processing" in 'RUN_GCS'. (2) P-Spec 2.1.1 "AECLP - Axial Engine Expand Data Flows". P-Spec is extraneous to the model design. <Action> Deleted P-Spec 2.1.1 from the model. (3) P-Spec 2.1.3 "AECLP - Axial Engine Compress Data Flows". P-Spec is extraneous to the model design. <Action> Deleted P-Spec 2.1.3 from the model. (4) P-Spec 2.1.2 "AECLP - Axial Engine Control Law Processing". <Action> Renamed this P-Spec to 2.1 making it the only P-Spec. (*) DFD 2.2 "ARSP". (1) DFD 2.2 "ARSP" is an unnecessary level of complexity in the model design. <Action> Deleted DFD 2.2 "ARSP" from the model. Retitled "ARSP" to "ARSP - Altimeter Radar Sensor Processing" in 'RUN_GCS'. (2) P-Spec 2.2.1 "ARSP - Altimeter Radar Expand Data Flows". P-Spec is extraneous to the model design. <Action> Deleted P-Spec 2.2.1 from the model. (3) P-Spec 2.2.3 "ARSP - Altimeter Radar Compress Data Flows". P-Spec is extraneous to the model design. <Action> Deleted P-Spec 2.2.3 from the model. (4) P-Spec 2.2.2 "ARSP - Altimeter Radar Sensor Processing". <Action> Renamed this P-Spec to 2.2 making it the only P-Spec.			
7. Was the action related to another action(s)? <div style="display: flex; justify-content: flex-end; align-items: center;"> <input type="checkbox"/> Yes AR#(s) <input checked="" type="checkbox"/> No <input type="checkbox"/> I don't know </div>			

Action Report Continuation

page 2 of 6

a. Report #:

2.01

b. Notes/Explanation (Please reference appropriate section number):

(***) DFD 2 'RUN_GCS'.

(*) DFD 2.3 "ASP".

- (1) DFD 2.3 "ASP" is an unnecessary level of complexity in the model design.

<Action> Deleted DFD 2.3 "ASP" from the model. Retitled "ASP" to "ASP - Accelerometer Sensor Processing" in 'RUN_GCS'.

- (2) P-Spec 2.3.1 "ASP - Accelerometer Expand Data Flows".

P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.3.1 from the model.

- (3) P-Spec 2.3.3 "ASP - Accelerometer Compress Data Flows".

P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.3.3 from the model.

- (4) P-Spec 2.3.2 "ASP - Accelerometer Sensor Processing".

<Action> Renamed this P-Spec to 2.3 making it the only P-Spec.

(*) DFD 2.4 "CP".

- (1) DFD 2.4 "CP" is an unnecessary level of complexity in the model design.

<Action> Deleted DFD 2.4 "CP" from the model. Retitled "CP" to "CP - Communications Processing" in 'RUN_GCS'.

- (2) P-Spec 2.4.1 "CP - Communications Processing Expand Data Flows".

P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.4.1 from the model.

- (3) P-Spec 2.4.3 "CP - Communications Processing Compress Data Flows".

P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.4.3 from the model.

- (4) P-Spec 2.4.4 "CP - Communications Processing Expand GUIDANCE_STATE Data Store".

P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.4.4 from the model.

- (5) P-Spec 2.4.2 "CP - Communications Processing".

<Action> Renamed this P-Spec to 2.4 making it the primary P-Spec.

- (6) Redrew DFD 2.4.5 bubble "CALCULATE CRC-16" off of bubble "CP" in 'RUN_GCS'. Renamed bubble "CALCULATE CRC-16" to .19 and renamed the P-Spec for "CALCULATE CRC-16" to .19.

Action Report Continuation

page 3 of 6

a. Report #:

2.01

b. Notes/Explanation (Please reference appropriate section number):

(***) DFD 2 'RUN_GCS'.

(*) DFD 2.5 "CRCP".

- (1) DFD 2.5 "CRCP" is an unnecessary level of complexity in the model design.

<Action> Deleted DFD 2.5 "CRCP" from the model. Retitled "CRCP" to "CRCP - Chute Release Control Processing" in 'RUN_GCS'.

- (2) P-Spec 2.5.1 "CRCP - Chute Release Expand Data Flows".

P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.5.1 from the model.

- (3) P-Spec 2.5.3 "CRCP - Chute Release Compress Data Flows".

P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.5.3 from the model.

- (4) P-Spec 2.5.2 "CRCP - Chute Release Control Processing".

<Action> Renamed this P-Spec to 2.5 making it the only P-Spec.

(*) DFD 2.6 "GSP".

- (1) DFD 2.6 "GSP" is an unnecessary level of complexity in the model design.

<Action> Deleted DFD 2.6 "GSP" from the model. Retitled "GSP" to "GSP - Gyroscope Sensor Processing" in 'RUN_GCS'.

- (2) P-Spec 2.6.1 "GSP - Gyroscope Sensor Processing Expand Data Flows".

P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.6.1 from the model.

- (3) P-Spec 2.6.3 "GSP - Gyroscope Sensor Processing Compress Data Flows".

P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.6.3 from the model.

- (4) P-Spec 2.6.2 "GSP - Gyroscope Sensor Processing".

<Action> Renamed this P-Spec to 2.6 making it the only P-Spec.

Action Report Continuation

page 4 of 6

a. Report #:

2.01

b. Notes/Explanation (Please reference appropriate section number):

(***) DFD 2 'RUN_GCS'.

(*) DFD 2.7 "GP".

- (1) DFD 2.7 "GP" is an unnecessary level of complexity in the model design.

<Action> Deleted DFD 2.7 "GP" from the model. Retitled "GP" to "GP - Guidance Processing" in 'RUN_GCS'.

- (2) P-Spec 2.7.1 "GP - Guidance Processing Data Expand".

P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.7.1 from the model.

- (3) P-Spec 2.7.3 "GP - Guidance Processing Data Compress".

P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.7.3 from the model design.

- (4) P-Spec 2.7.2 "GP - Guidance Processing".

<Action> Renamed this P-Spec to 2.7, making it the only P-Spec.

(*) DFD 2.8 "RECLP".

- (1) DFD 2.8 "RECLP" is an unnecessary level of complexity in the model design.

<Action> Deleted DFD 2.8 "RECLP" from the model. Retitled "RECLP" to "RECLP - Roll Engine Control Law Processing" in 'RUN_GCS'.

- (2) P-Spec 2.8.1 "RECLP - Roll Engine Control Law Processing Data Expand".

P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.8.1 from the model.

- (3) P-Spec 2.8.3 "RECLP - Roll Engine Control Law Processing Data Compress".

P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.8.3 from the model design.

- (4) P-Spec 2.8.2 "RECLP - Roll Engine Control Law Processing".

<Action> Renamed this P-Spec to 2.8, making it the only P-Spec.

Action Report Continuation

page 5_ of 6

a. Report #:

2.01

b. Notes/Explanation (Please reference appropriate section number):

(***) DFD 2 'RUN_GCS'.

(*) DFD 2.9 "TDLRSP".

- (1) DFD 2.9 "TDLRSP" is an unnecessary level of complexity in the model design.

<Action> Deleted DFD 2.9 "TDLRSP" from the model. Retitled "TDLRSP" to "TDLRSP - Touch Down Landing Radar Sensor Processing" in 'RUN_GCS'.

- (2) P-Spec 2.9.1 "TDLRSP - Touch Down Landing Radar Sensor Processing Data Expand".

P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.9.1 from the model.

- (3) P-Spec 2.9.3 "TDLRSP - Touch Down Landing Radar Data Comp".

P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.9.3 from the model.

- (4) P-Spec 2.9.2 "TDLRSP - Touch Down Landing Radar Sensor Processing".

<Action> Renamed this P-Spec to 2.9, making it the only P-Spec.

(*) DFD 2.10 "TDSP".

- (1) DFD 2.10 "TDSP" is an unnecessary level of complexity in the model design.

<Action> Deleted DFD 2.10 "TDSP" from the model. Retitled "TDSP" to "TDSP - Touch Down Sensor Processing" in 'RUN_GCS'.

- (2) P-Spec 2.10.1 "TDSP - Touch Down Expand Data Flows".

P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.10.1 from the model.

- (3) P-Spec 2.10.3 "TDSP - Touch Down Compress Data Flows".

P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.10.3 from the model.

- (4) P-Spec 2.10.2 "TDSP - Touch Down Sensor Processing".

<Action> Renamed this P-Spec to 2.10, making it the only P-Spec.

Action Report Continuation

page 6 of 6

a. Report #:

2.0/1

b. Notes/Explanation (Please reference appropriate section number):

(***) DFD 2 'RUN_GCS'.

(*) DFD 2.11 "TSP".

(1) DFD 2.11 "TSP" is an unnecessary level of complexity in the model design.

<Action> Deleted DFD 2.11 "TSP" from the model. Retitled "TSP" to "TSP - Temperature Sensor Processing" in 'RUN_GCS'.

(2) P-Spec 2.11.1 "TSP - Temperature Sensor Processing Data Expand". P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.11.1 from the model.

(3) P-Spec 2.11.3 "TSP - Temperature Sensor Processing Data Compress" P-Spec is extraneous to the model design.

<Action> Deleted P-Spec 2.11.3 from the model.

(4) P-Spec 2.11.2 "TSP - Temperature Sensor Processing".

<Action> Renamed this P-Spec to 2.11 making it the only P-Spec.

GCS Problem Report

page 1 of 2

1. PR #: 3.0	2. Planet: PLUTO	3. Discovery Date: Oct 15, 1993	4. Initiator & Role: Inspectors/ Quach and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design	X									
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The following problems were identified in the TSP functional unit:

- 1) The data element TS_STATUS, contained in the data flow named TEMP_GS_IN, is depicted as an input to the process 2.11 TSP. This is inconsistent with the TSP process as defined in the GCS Software Requirements.
- 2) The algorithm for determining the atmospheric temperature as computed from the data provided by the solid-state temperature sensor is lacking an adequate description. The design does not provide enough information to derive the equations.
- 3) The algorithm for determining the atmospheric temperature as computed from the data provided by the thermocouple-pair temperature sensor is lacking an adequate description. The design does not provide enough information to derive the equations if necessary for a future modification.

7. Artifact Identification:

<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:
<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	Pluto Design Description
<input type="checkbox"/> Executable Object Code		P-Spec 2.11 TSP - Temperature Sensor Processing

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
4/11/94	4/18/94	Angellatta		31
4/18/94	4/19/94	Quach		
4/19/94	4/20/94	Hayhurst		

10. Total # of Changes: **4**

11. Total # of No Changes: **0**

12. Initiator Signature & Date

Original Signed by
Patrick Quach

4-17-94

13. SOA Signature & Date

Original Signed by
Kelly Hayhurst

4/20/94

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 2

a. Report #: 3.0

b. Notes/Explanation (Please reference appropriate section number):

4) In reference to the following code segment (page 4):

```
*****
* Determine which expression to use to calculate *
* THERMOCOUPLE temperature: *
*****
```

```
      "if (THERMO TEMP >= lo meas limit tc
          and
          THERMO TEMP < M3..."    ...
```

```
      "ELSE IF (THERMO TEMP > m4
          AND
          THERMO TEMP <= hi meas limit tc)"
```

Problem: In the first conditional, the first relational expression is unnecessary, and in the second conditional the second relational expression is unnecessary.

5) All of the local variables of type REAL are declared as single precision -- real*4. It is possible to lose precision in the computation of the atmospheric temperature.

GCS Action Report

page 1 of 1

1. AR#: 3.1	2. Planet: Pluto	3. Date of Action: April 19, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
5. Artifact Identification: <input checked="" type="checkbox"/> Design Description Source Code Executable Object Code		Support Documentation Other	Configuration Item: Pluto Design Description P-Spec 2.11 TSP
6. Description of Action 1) The data element TS_STATUS was removed from the list of inputs for P-Spec 2.11. The data flow labeled TEMP_GS_IN was removed from DFD 2. The data dictionary entry TEMP_GS_IN was removed from the data dictionary as it simply renamed the data element TS_STATUS. 2) P-Spec 2.11 has been modified to include a complete description of the algorithm for computing the atmospheric temperature from the measurement provided by the solid-state sensor. 3) P-Spec 2.11 has been modified to include a complete description of the algorithm for computing the atmospheric temperature from the measurement provided by the Thermocouple-pair sensor. 4) The "code segment" in question has been redesigned to avoid unnecessary relational evaluations. 5) Since this is really a <i>design</i> and not <i>code</i> , all references to variable types have been removed from P-Spec 2.11. EXTRA: X1) It seems extraneous to create a data flow to contain a single data element. In DFD 2, the data flow labeled TEMP_GS_OUT was relabeled to TS_STATUS and the data dictionary element TEMP_GS_OUT has been removed from the data dictionary. X2) In DFD 2, the data flow labeled TEMP_SO_OUT was relabeled to ATMOSPHERIC_TEMP and the data dictionary element TEMP_SO_OUT has been removed from the data dictionary. NOTES: <div style="text-align: center; padding: 10px;">The entire P-Spec 2.11 TSP has been redesigned.</div>			
7. Was the action related to another action(s)? <div style="text-align: right; padding-right: 50px;"> Yes AR#(s) <input checked="" type="checkbox"/> No Do not know </div>			

GCS Problem Report

page 1 of 2

1. PR #: 4.0	2. Planet: Pluto	3. Discovery Date: Oct. 15, 1993	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design	X									
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The following are inconsistencies and deficiencies for the ARSP PSpec. 2.2 in the Pluto Design Description that need to be addressed.

1) In reference to the following pseudo-code on page 2

```

if (FRAME_COUNTER == even)
    AR_ALTITUDE.* = AR_ALTITUDE.[previous value]
    AR_STATUS.* = AR_STATUS.[previous value]
    K_ALT.* = K_ALT.[previous value]"
    
```

- The "." syntax (used throughout the PSpec) is inconsistent with its definition.
- The expression "[previous value]" does not clearly stipulate which previous value of the FIFO to use.
- The description for the FIFO operation directly before this code is very vague. Adding this code implies an extra FIFO shift on even FRAME_COUNTER.

7. Artifact Identification:

<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:
<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	Pluto Design Description
<input type="checkbox"/> Executable Object Code		

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
4/20/94		Angellatta		4.1
4/29/94	4/29/94	Quach		
4/29/94	5/8/94	Hayhurst		

10. Total # of Changes: 8

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by
Patrick Quach

4-29-94

13. SOA Signature & Date

Original Signed by
Kelly Hayhurst

5/2/94

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 2

a. Report #:

4.0

b. Notes/Explanation (Please reference appropriate section number):

- 2) To estimate the altitude when sensor data (namely AR_COUNTER) is not available, the Newton Divide Difference is used. It (the Newton Method) is describe as a series operations to build a table from which the next value is estimated.
- a) The ordering of the entries in the table (which can affect the final result) is not specified.
 - b) The operand ordering in operations to build successive columns (after column 1) is also not specified.
 - c) Insufficient explanation for Newton Method.

- 3) With reference to the following on page 3 of ARSP PSpec.

```
if (AR_FREQUENCY == 0) ...
```

- a) AR_FREQUENCY is unnecessarily tested for zero.
 - b) Non-FORTRAN 77 notation is used in the "if" clause.
- 4) A lower limit check is performed after AR_ALTITUDE is calculated, but an upper limit check is not performed. Further, when an extrapolating AR_ALTITUDE, neither limits are tested.
- 5) In the pseudo-code to calculate AR_ALTITUDE on page 3:

```
AR_ALTITUDE.[0] = (AR_COUNTER * 3 * 10**8 ) / AR_FREQUENCY * 2
```

The order of operation of the last divide and multiply is left open for interpretation.

- 6) With reference to the limits checking on page 2 for the following input variables:

```
AR_STATUS  
K_ALT  
AR_ALTITUDE
```

Limits are checked only when the FRAME_COUNTER is even. This does not cover odd FRAME_COUNTERS

GCS Action Report

page 1 of 1

1. AR#: 4.1	2. Planet: Fluto	3. Date of Action: April 29, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
5. Artifact Identification: X Design Description Source Code Executable Object Code		Support Documentation Other	Configuration Item: Pluto Design Description P-Spec 2.2 ARSP
<p>6. Description of Action</p> <div style="display: flex;"> <div style="width: 10%; font-size: small; padding-right: 10px;"> Not necessary to attach test </div> <div style="flex-grow: 1;"> <ol style="list-style-type: none"> 1) a) All data elements previously reference using the ambiguous syntax ".*" have been modified as necessary to reference specific array elements. The ".*" syntax has been highlighted in the enclosed "old" version of P-Spec 2.2. The changes are too numerous to explicitly document in the "new" version of P-Spec 2.2 b) and c) The statements in question are not necessary and have been removed from the design (note 1c). Additionally, the "rotate variables" algorithm has been replaced and now explicitly describes the concept of "shifting" (note 1x). 2) a), b), and c) The design has been modified to include a complete description of how the divided difference method is applied in deriving the equation for extrapolating the altitude (note 2). The previous description has been removed from the design. 3) The cited statement is not necessary and has been removed from the design. 4) In accordance with GCS Development Specification v 2.3, range checking is no longer necessary for AR_ALTITUDE in this module. So, the range checking that was present has been removed. 5) The cited statement has been modified to describe the proper equation (note 5). 6) In accordance with GCS Development Specification v 2.3, range checking is no longer necessary for AR_ALTITUDE, AR_STATUS, or K_ALT in this module. So, the range checking that was present has been removed. </div> </div>			
<p>7. Was the action related to another action(s)?</p> <div style="display: flex; justify-content: flex-end; align-items: center;"> <div style="margin-right: 20px;"> <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Do not know </div> <div> AR#(s) </div> </div>			

GCS Problem Report

page 1 of 2

1. PR #: 5	2. Planet: Pluto	3. Discovery Date: Oct. 15, 1993	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design	X									
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The following are inconsistencies and deficiencies for the ASP unit (PSpec. 2.3) in the Pluto Design Description that need to be addressed.

- 1) In reference Local variables declared at the beginning of the ASP PSpec:

```
BEGIN LOCAL TYPE DEFS
    real a_gain.*
    .
    .
    real hold
END LOCAL TYPE DEFS"
```

Variable size is ambiguous.

- 2) Description for rotating history variables is vague. The "*" notation is not used according to its definition in the Design Description Preface

7. Artifact Identification:

<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item: Pluto Design Description
<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	
<input type="checkbox"/> Executable Object Code		

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
5/2/94	5/2/94	Angellatta		5.1
5/2/94	5/2/94	Quach		
5/2/94	5/2/94	Hayhurst		

10. Total # of Changes: 6

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by
Patrick Quach

5-2-94

13. SOA Signature & Date

Original Signed by
Kelly Hayhurst

5/2/94

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 2

a. Report #:

5

b. Notes/Explanation (Please reference appropriate section number):

3) In reference to the following:

at = ATMOSPHERIC_TEMP

Shortening the variable name makes the subsequent equation less obvious.

4) Notation used for the pseudo-code which calculates the standard deviation is very confusing and can be misinterpreted.

5) In reference to the notation describing axis alignment:

accel.* = ALPHA_MATRIX.* * accel.*

The required matrix multiplication is not apparent from the notation.

6) In reference to status check of previous STATUS values:

if [A_STATUS.*(all 1..3)]...

It is not clear which variable is being tested.

GCS Action Report

page 1 of 1

1. AR#: 5.1	2. Planet: Pluto	3. Date of Action: May 2, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
5. Artifact Identification: <input checked="" type="checkbox"/> Design Description Source Code Executable Object Code		Support Documentation Other	Configuration Item: Pluto Design Description P-Spec 2.3 ASP
6. Description of Action 1) Since this is really a <i>design</i> and not <i>code</i> , all references to variable types have been removed from P-Spec 2.3. Local data elements are referenced where necessary; their types must be determined during the implementation process. 2) All data elements previously reference using the ambiguous syntax ".*" have been modified as necessary to reference specific array elements. The "rotate variables" algorithm has been replaced and now explicitly describes the concept of "shifting." 3) The design has been modified such that the data element ATMOSPHERIC_TEMP is not renamed to "at." 4) The algorithm for specifying the standard deviation operation has been modified in ^{an} an effort to reduce ambiguity. 5) A statement has been added to the design explicitly noting the matrix multiplication. 6) The cited statement has been modified to explicitly reference the array entries of the data element A_STATUS.			
7. Was the action related to another action(s)? <div style="text-align: right;"> Yes AR#(s) <input checked="" type="checkbox"/> No Do not know </div>			

GCS Problem Report

page 1 of 1

1. PR #: 6	2. Planet: Pluto	3. Discovery Date: Oct. 15, 1993	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	IRR	TCR	TCC	TCE	R	O
Design	X									
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The following are inconsistencies and deficiencies for the GSP unit (PSpec. 2.6) in the Pluto Design Description that need to be addressed.

- 1) The variable G_STATUS is incorrectly listed as an input.
- 2) The description is ambiguous for shifting the history variable G_ROTATION.
- 3) Loss of precision occurs due to assignment of ATMOSPHERIC_TEMP and G_GAIN to local buffers declared as "REAL*4".
- 4) With reference to the "IAND" function used in the 2's complement conversion; "IAND" is a VAX FORTRAN extension and not standard FORTRAN 77 notation.

7. Artifact Identification:

<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:
<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	Pluto Design Description
<input type="checkbox"/> Executable Object Code		

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
5/2/94		Angellatta		6.1
	5/4/94	Quach		
5/4/94		Hayhurst		

10. Total # of Changes: 9

11. Total # of No Changes: 0

12. Initiator Signature & Date

13. SOA Signature & Date.

Original Signed by
Patrick Quach

5-4-94

Original Signed by
Kelly Hayhurst

5/4/94

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

GCS Action Report

page 1 of 2

1. AR#: 6.1	2. Planet: Pluto	3. Date of Action: May 3, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
5. Artifact Identification: X Design Description Source Code Executable Object Code		Support Documentation Other	Configuration Item: Pluto Design Description P-Spec 2.6 GSP
6. Description of Action			
<p>1) The data element G_STATUS was removed from the list of inputs for P-Spec P-Spec 2.6. The data flow labeled GYRO_GS_IN was removed from DFD 2. The data dictionary entry GYRO_GS_IN was removed from the data dictionary as it simply renamed the data element G_STATUS.</p> <p>2) The "rotate variables" algorithm has been replaced and now explicitly describes the concept of "shifting" the history data element G_ROTATION.</p> <p>3) Since this is really a <i>design</i> and not <i>code</i>, all references to variable types have been removed from P-Spec 2.6.</p> <p>4) The syntax used to describe the design has been altered and no longer follows FORTRAN-77 syntax. The portion of the design which calls for a two's complement conversion has been restated with additional comments included in the description.</p> <p>EXTRA:</p> <p>Several of the data flows entering/exiting P-Spec 2.6 GSP contain a single data element. This serves to simply rename a data flow. These data flows have been removed from the data dictionary and the flows, which appear in DFD 2 RUN_GCS, have been renamed to the single data element they originally represented.</p> <p>1X) The data flow named GYRO_EXT_IN contained the single data element G_COUNTER. This flow has been deleted from the data dictionary and DFD 2 RUN_GCS has been modified replacing GYRO_EXT_IN with G_COUNTER as input to P-Spec 2.6 GSP. The data dictionary entry named EXTERNAL has also been modified replacing the entry GYRO_EXT_IN with G_COUNTER.</p> <p>2X) The data flow named GYRO_SO_OUT contained the single data element G_ROTATION. This flow has been deleted from the data dictionary and DFD 2 RUN_GCS has been modified replacing GYRO_SO_OUT with G_ROTATION.</p> <p>3X) The data flow named GYRO_GS_OUT contained the single data element G_STATUS. This flow has been deleted from the data dictionary and DFD 2 RUN_GCS has been modified replacing GYRO_GS_OUT with G_STATUS.</p>			
7. Was the action related to another action(s)?		Yes AR#(s) X No Do not know	

Action Report Continuation

page 2 of 2

a. Report #:

6.1

b. Notes/Explanation (Please reference appropriate section number):

4X) In accordance with GCS Development Specification v 2.3, range checking is no longer necessary for G_ROTATION in this module. So, the range checking that was present has been removed.

GCS Problem Report

page 1 of 2

1. PR #: 7	2. Planet: Pluto	3. Discovery Date: Oct. 15, 1993	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design	X									
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The following are inconsistencies and deficiencies for the TDLRSP PSpec. 2.9 in the Pluto Design Description that need to be addressed.

- 1) Use of the "."* and the ".#" notation in the local type definition is unclear and not consistent with their previous definition.
- 2) FIFO data shift description is ambiguous. Direction of rotation is not specified in "Rotate variable"
- 3) The limit checking for TDLR_VELOCITY on page 2 of the PSpec uses a ".x" notation. This is not previously explained.
- 4) The limit checking for K_MATRIX is unclear and unnecessary.

7. Artifact Identification:

<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item: Pluto Design Description
<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	
<input type="checkbox"/> Executable Object Code		

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
5/4/94	5/6/94	Angellatta		7.1
5/6/94	5/6/94	Quach		
5/6/94	5/6/94	Hayhurst		

10. Total # of Changes: 9

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by Patrick Quach 5-6-94

13. SOA Signature & Date

Original Signed by Kelly Hayhurst 5/6/94

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 2

a. Report #:

7

b. Notes/Explanation (Please reference appropriate section number):

5) In reference to the description for even FRAME_COUNTER processing:

```
if (FRAME_COUNTER == even)
    set TDLR_VELOCITY.* to previous value of TDLR_VELOCITY.*
    set K_MATRIX.* to previous value of K_MATRIX.*
    exit.
```

a) The statement "Set ... to previous value of ..." are ambiguous.

b) Typo. "TDLR_VELOCITYV.*"

6) Unnecessary limit checking for:

a) TDLR_STATE

b) FRAME_BEAM_UNLOCKED

c) TDLR_VELOCITY

7) The IF cluster of statement which test whether a beam is locked and can be used:

a) The logic for the Locked and unlocked case is not mutually exclusive..

b) FRAME_BEAM_UNLOCKED is incorrectly set.

8) A description for calculating vehicle average velocities (page 4) for classes 2 to 4 is missing.

9) The description to calculate the average velocity:

```
beam_vel.# = TDLR_OFFSET + (TDLR_GAIN * TDLR_COUNTER.#)
```

Ambiguous description of the processing sequence to calculate individual beam velocities and average beam velocity.

GCS Action Report

page 1 of 1

1. AR#: 7.1	2. Planet: Pluto	3. Date of Action: May 6, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
5. Artifact Identification:		Configuration Item:	
<input checked="" type="checkbox"/> Design Description Source Code Executable Object Code		Support Documentation Other Pluto Design Description P-Spec 2.9 TDLRSP	
6. Description of Action			
<ol style="list-style-type: none"> 1) All data elements previously reference using the ambiguous syntax ".*" and ".#" have been modified as necessary to reference specific array elements. 2) The "rotate variables" algorithm has been replaced and now explicitly describes the concept of "shifting" the history data elements TDLR_VELOCITY and K_MATRIX. 3) In accordance with GCS Development Specification v 2.3, range checking is no longer necessary for TDLR_VELOCITY in this module. So, the range checking that was present has been removed. 4) The range checking for K_MATRIX has been removed. 5) a) and b) The cited statements have been removed from the design as they are not necessary. 6) The range checking for TDLR_STATE, FRAME_BEAM_UNLOCKED, and TDLR_VELOCITY has been removed from the design. 7) a) and b) The description for determining the "beam state" has been modified to improve clarity and correct the cited deficiencies. 8) A complete description for computing the vehicle average velocities, also referred to as the "processed" beam velocities, for all classes has been added to the design. 9) The description for computing the beam velocities has been modified to remove the ambiguous syntax ".#". 			
7. Was the action related to another action(s)?			
<div style="text-align: right;"> Yes AR#(s) <input checked="" type="checkbox"/> No Do not know </div>			

GCS Problem Report

page 1 of 1

1. PR #: 8	2. Planet: Pluto	3. Discovery Date: Oct. 15, 1993	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design	X									
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The following are inconsistencies and deficiencies for the TDSP PSpec. 2.10 in the Pluto Design Description that need to be addressed.

- 1) The term "unhealthy" used in the PSpec is not consistent with what is used in the Specification.
- 2) The assignment:

all_ones = -1

assumes that 2s' complement is used for TD_COUNTER, This may or may not be true of the platform that is going to host the executable code.
- 3) The last branch in the TD_STATUS if statement:

else

Give message "TDS_STATUS has bad value..."

This branch is unnecessary
- 4) Limits testing for the following are unnecessary.

TD_SENSED

TDS STATUS

7. Artifact Identification:

<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item: Pluto Design Description
<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	
<input type="checkbox"/> Executable Object Code		

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
5/6/94		Angellatta		8.1
	5/9/94	Quach		
5/9/94	5/10/94	Hayhurst		

10. Total # of Changes: 4

11. Total # of No Changes:

<p>12. Initiator Signature & Date</p> <p>Original Signed by <u>Patrick Quach</u> <u>5-9-94</u></p>	<p>13. SOA Signature & Date</p> <p>Original Signed by <u>Kelly Hayhurst</u> <u>5/10/94</u></p>
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* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

GCS Action Report

page 1 of 1

1. AR#: 8.1	2. Planet: Pluto	3. Date of Action: May 6, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
5. Artifact Identification: X Design Description Source Code Executable Object Code		Support Documentation Other	Configuration Item: Pluto Design Description P-Spec 2.10 TDSP
6. Description of Action 1) The term "unhealthy" has been removed from P-Spec 2.10. References to the term have been replace with the value "1" and commented with the appropriate term "failed." 2) The syntax for referencing "all_ones" has been modified to use hexadecimal notation. 3) The cited statement is unnecessary and has been removed from the design. 4) The cited range checking is unnecessary and has been removed from the design.			
7. Was the action related to another action(s)? Yes AR#(s) X No Do not know			

GCS Problem Report

page 1 of 2

1. PR #: 9	2. Planet: Pluto	3. Discovery Date: Oct. 15, 1993	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	IRR	TCR	TCC	TCE	R	O
Design	X									
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The following are inconsistencies and deficiencies for the RECLP PSpec. 2.8 in the Pluto Design Description that need to be addressed.

- 1) Unnecessary range checking for RE_SWITCH on top of page 2.
- 2) When performing range checking for G_ROTATION, the notation G_ROTATION.x ... is ambiguous. Since G_ROTATION is a 3 by 5 matrix, it is not clear which element is being tested.
- 3) Concerning the limit checking for the variable THETA:
 - a) The variable PI is assumed to have the mathematical value. Its value as used in the context of this bounds checking is not clearly defined
 - b) The limit checking forces THETA to be exactly PI. This is incorrect.
- 4) References to the figure which describes roll engine command settings should be updated.
- 5) The description for determining the region of interest on the roll engine command graph with which to derive the roll engine command lacks sufficient detail to derive an algorithm.

7. Artifact Identification:

☒ Design Description
☐ Source Code
☐ Executable Object Code

☐ Support Documentation
☐ Other

Configuration Item:
Pluto Design Description

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
5/10/94	5/10/94	Angellatta		9.1
5/10/94	5/11/94	Quach		
5/11/94	5/11/94	Hayhurst		

10. Total # of Changes: 7

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by
 Patrick Quach

5-11-94

13. SOA Signature & Date

Original Signed by
 Kelly Hayhurst

5/11/94

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 2

a. Report #:

9

b. Notes/Explanation (Please reference appropriate section number):

- 6) The description for building the roll engine command uses the terms
lowest bit
second lowest bit
third lowest bit
but does not specifically define the notation used.
- 7) Concerning the programming instructions for the last "else" branch
which contains the comment "you should not be able to reach this region..."
a) It is not clear which part of the Specification this logic traces to.
b) The instruction to print error message is inadequate.

GCS Action Report

page 1 of 1

1. AR#: 9.1	2. Planet: Pluto	3. Date of Action: May 11, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
5. Artifact Identification: <div style="display: flex; justify-content: space-between;"> <div style="width: 30%;"> <input checked="" type="checkbox"/> Design Description Source Code Executable Object Code </div> <div style="width: 30%;"> Support Documentation Other </div> <div style="width: 35%;"> Configuration Item Pluto Design Description P-Spec 2.8 RECLP </div> </div>			
6. Description of Action <ol style="list-style-type: none"> 1) Range checking of the data element RE_SWITCH has been removed from P-Spec 2.8. 2) The range checking for the x-axis vehicle rotation rate has been modified to specify data element G_ROTATION(1, 0). 3) a) P-Spec 2.8 has been modified giving a specific value for "PI." b) The range checking of the data element THETA has been corrected. 4) The cited reference has been updated to reflect the version 2.3 of the GCS development specification. 5) A complete description of the algorithm for determining the roll engine command has been provided in P-Spec 2.8. 6) The description for determining the roll engine command has been modified (item 5) and the cited terms have been removed from P-Spec 2.8 7) The cited "else" statement is unnecessary and has been removed from P-Spec 2.8. 			
7. Was the action related to another action(s)? <div style="display: flex; justify-content: flex-end; margin-top: 5px;"> <div style="text-align: right; margin-right: 20px;"> Yes AR#(s) <input checked="" type="checkbox"/> No Do not know </div> </div>			

GCS Problem Report

page 1 of 2

1. PR #: 10	2. Planet: Pluto	3. Discovery Date: Oct. 15, 1993	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design	X									
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The following are inconsistencies and deficiencies for the AECLP P-Spec.. 2.1 in the Pluto Design Description that need to be addressed.

- 1) Unnecessary range checking for AE_SWITCH on page 3.
- 2) An algorithm for the AE_TEMP is missing.
- 3) In calculating theta(local variable) for the PE_INTEGRAL and the YE_INTEGRAL:
 - a) GP_VELOCITY is a 2 dimensional matrix but only 1 dimension is referenced in the divide by zero check as well as the theta calculation.
 - b) The Spec. indicates that the absolute value of the GP_VELOCITY component is to be used in the divide.
 - c) The name of local variable "theta" may conflict with the global variable name "THETA" in some implementation languages.
- 4) Unnecessary boundary check for:

AE_TEMP
 CONTOUR_CROSSED

7. Artifact Identification:

<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:
<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	Pluto Design Description
<input type="checkbox"/> Executable Object Code		P-Spec 2.1 (kgu)

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
5/11/94		Angellatta		10.1
	5/31/94	Quach		
5/31/94	6/2/94	Hayhurst		

10. Total # of Changes: 15

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by 5-31-94
Patrick Quach

13. SOA Signature & Date

Original Signed by 6/2/94
Kelly Hayhurst

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 2

a. Report #:

10

b. Notes/Explanation (Please reference appropriate section number):

- 5) The calculation for limiting_pitch_error and limiting_yaw_error are done in 2 steps unnecessarily.
- 6) With reference to the bounds checking for the following:
 - a) A_ACCELERATION uses 2 different indexing notations to reference the element being tested; it is not clear which element is being tested
 - b) The 1 dimension array, GP_ALTITUDE, is referenced as a 3 dimensional array.
 - c) Bounds checking is missing for the following:
GP_ATTITUDE,
GP_VELOCITY
 - d) Nesting the bounds checking inside the if statements makes the if blocks very difficult to follow. It is not clear whether the bounds checking is actually performed.
- 7) The design includes assignments of TE_LIMIT based on AE_TEMP. This is not in the Spec.
- 8) The design has not shown the derivation of the equation used to solve the differential equation for TE_LIMIT.
- 9) In reference to the following description for calculation TE_LIMIT:
$$q_temp = -GAX(\dots * GP_ALTITUDE(1,3,0) \dots VELOCITY_ERROR + GVEI(CI * TE_INTEGRAL$$
$$q_over_omega = (GA * (q_temp + GVEI(CI) * TE_INTEGRAL)) / OMEGA$$
 - a) In the equation for q_temp, the term "GP_ALTITUDE(1,3,0)" is incorrect.
 - b) The equation for q_temp has unbalanced parentheses making it ambiguous.
 - c) q_over_omega is incorrect because the term " GVEI(CI) * TE_INTEGRAL" is in the equation twice.
- 10) The variable TE_LIMIT is not included in its limit processing, a local variable is used instead. This leaves the variable, TE_LIMIT, unchecked when processing is completed for this P-Spec.
- 11) In reference to the description for clearing the pitch, yaw, and thrust error based on AE_SWITCH:

```
if (AE_SWITCH == off)
    pitch_error = 0.
    yaw_error = 0.
    thrust_error = 0.
```

This added functionality is not defined in the Spec.
- 12) The following IF blocks have closing ELSE branches where processing to be performed is inadequately described. The instructions are vaguely to "Give error message."
 - a) The IF structure for calculating the TE_INTEGRAL.
 - b) The IF structure for determining pitch, yaw and thrust error.
 - c) The IF structure for determining AE_CMD.
- 13) Unnecessary bounds checking for CHUTE_RELEASED.
- 14) Unnecessary introduction of temporary variable, "Int_cmd", when determining the value of AE_CMD.
- 15) The rounding step for AE_CMD is missing.

GCS Action Report

page 1 of 2

1. AR#: 10.1	2. Planet: Pluto	3. Date of Action: May 26, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
5. Artifact Identification:		Configuration Item:	
<input checked="" type="checkbox"/> Design Description Source Code Executable Object Code		Support Documentation Other Pluto Design Description P-Spec 2.1 AECLP	
6. Description of Action			
<p>1) In accordance with formal mod. 2.2-28 the range checking for the data element AE_SWITCH is unnecessary. The range checking for the data element AE_SWITCH has been removed from P-Spec 2.1 AECLP.</p> <p>2) An algorithm for determining the value of data element AE_TEMP has been inserted into the design.</p> <p>3) The algorithm for determining the value of data element PE_INTEGRAL has been modified such that:</p> <p style="margin-left: 20px;">a) the correct element of GP_VELOCITY is referenced;</p> <p style="margin-left: 20px;">b) An absolute value operation is performed as stated in the GCS Software Requirements; and</p> <p style="margin-left: 20px;">c) The local data element "theta" has been removed from the design.</p> <p>4) The unnecessary range checking for the data elements AE_TEMP and CONTOUR_CROSSED have been removed from P-Spec 2.1 AECLP.</p> <p>5) The computation of "limiting_pitch_error" (renamed to "pitch_error_limit") has been modified and is now expressed by a single equation. Likewise, the computation of "limiting_yaw_error" (renamed to "yaw_error_limit") has been modified and is now expressed by a single equation.</p> <p>6) a) The indexing notation for the data element A_ACCELERATION has been modified to clearly indicate which element is being referenced.</p> <p style="margin-left: 20px;">b) References to the data element GP_ALTITUDE have been modified to be consistent with the data element declaration (ie. a single dimension array).</p> <p style="margin-left: 20px;">c) Range checking has been added where appropriate for elements of the the data elements GP_ATTITUDE and GP_VELOCITY.</p> <p>7) The assignment of the data element TE_LIMIT based on the value of data element AE_TEMP has been removed from the design.</p> <p>8) Due to the mathematical symbols involved, the derivation of the equation specifying the computation for TE_LIMIT will be included in the appropriate section of the design "introduction".</p>			
7. Was the action related to another action(s)?			
Yes AR#(s) <input checked="" type="checkbox"/> No Do not know			

Action Report Continuation

page 2 of 2

a. Report #:

10.1

b. Notes/Explanation (Please reference appropriate section number):

- 9) The computation of TE_LIMIT has been corrected.
 - a) The data element GP_ATTITUDE(1,3,0) has been substituted for the data element GP_ALTITUDE(1,3,0).
 - b) The parentheses in the expression of "q" (formerly "q_temp") are now balanced.
 - c) The term "q_over_omega" has been removed from the computation of TE_LIMIT.
- 10) Range checking for the data element TE_LIMIT is included where applicable.
- 11) The cited description has been removed from the design.
- 12) The "Give error message" branches cited have been removed from the design.
- 13) In accordance with formal mod. 2.2-28 the range checking for the data element CHUTE_RELEASED has been removed from P-Spec 2.1 AECLP.
- 14) The algorithm for determining the value of data element AE_CMD has been modified and the data element "int_cmd" removed from the description.
- 15) Although implicit in the original design, the algorithm for determining the value of the data element AE_CMD has been modified to explicitly express the "rounding" operation.

GCS Problem Report

page 1 of 3

1. PR #: 11	2. Planet: Pluto	3. Discovery Date: Oct. 15, 1993	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design	X									
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The following are inconsistencies and deficiencies for the CP (P-Spec.. 2.4) and CALCULATE CRC-16 (P-Spec. 2.19) in the Pluto Design Description that need to be addressed.

COMMUNICATIONS PROCESS P-Spec 2.4 deficiencies:

- 1) The following variables are listed as Inputs /outputs to the P-Spec but are not listed in the GCS Spec:
 - a) Inputs:
C_STATUS, CL, AE_SWITCH, CHECKSUM, FRAME_BEAM_UNLOCKED, FRAME_ENGINES_IGNITED, INTERNAL_CMD, ITH_FRAME_5, ITH_FRAME_2, RE_SWITCH, TDLRSP_SWITCH, TDSP_SWITCH, TE_LIMIT, THETA
 - b) Outputs:
NBYTES, BYTE_PACKET.
- 2) According to DFD-2, bubble 2.19(CALCULATE CRC-16) only has data flows to and from bubble 2.4(CP). This violates Structure Analysis DFD conventions as extended by Hatley and Pirbhat for real time systems. It also results in a P-Spec referencing another P-Spec as implied by the "call CALCULATE CRC-16".

7. Artifact Identification:

☒ Design Description
☐ Source Code
☐ Executable Object Code

☐ Support Documentation
☐ Other

Configuration Item:

Pluto Design Description
 P-spec 2.4 and 2.19

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
6/2/94		Angellatta		11.1
	6/2/94	Quach		
6/9/94	6/9/94	Hayhurst		
		(J)		

10. Total # of Changes: 20

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by
 Patrick Quach

6-9-94

13. SOA Signature & Date

Original Signed by
 Kelly Hayhurst

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 3

a. Report #: 11

b. Notes/Explanation (Please reference appropriate section number):

- 3) Concerning the table which spans from the bottom of page 3 to page 4
 - a) The notation used for Init_sample_mask_sub_fr_1 and 2 and 3 is not explained.
 - b) The intent of the table is not very clearly explained and is incomplete.
 - c) Some variables are missing.
 - 4) For subframe 1 and the case where its lth_frame_2 and not lth_frame_5:
 - a) K_MATRIX's mask bit is not set.
 - b) When it is packed, all elements are sent contrary to Spec.
 - 5) For subframe 1 and the case where its lth_frame_2 and lth_frame_5:
the data mask bits for K_ALT and K_MATRIX are not set.
 - 6) In the processing for subframe 2, the description for packing the array variable "GP_ROTATION" does not indicate that only the diagonal elements from the matrix are to be packed (as stated in the Spec.).
 - 7) There is no description for the special treatment of history variables as provided in the Spec.
 - 8) In each case where a specific list of variables is given to be packed, the lists start with a comment such as:
 subframe1 variable
 subframe two's variables
 subframe three's variables
It is not clear whether this comment is in the list to indirectly reference the actual variables
 - 9) A description for how the information is organized in the packet to be transmitted is necessary. Vague references to byte placements are inadequate.
 - 10) In reference to the IF-ELSE block which handles the different subframe counters, the variable "sub_frame_counter" is used but not specifically defined.
 - 11) The description for deriving a value for the variable "NBYTES" is not clear.
 - 12) The last ELSE block in the subframe checks accommodates the case where the subframe counter is invalid, this is not required by the Spec.
 - 13) The calling syntax and argument usage of the process CRC-16 is not clear.
 - 14) The description for packing the CRC-16 checksum into the "BYTE_PACKET" is incorrect since the CRC-16 is only 16 bits.
 - 15) C_STATUS is set to healthy at the end of the P-Spec. Contrary to the Spec. which requires it to be set prior to calculating the CHECKSUM and prior to loading C_STATUS into BYTE_PACKET and PACKET.
- CALCULATE CRC-16 P-Spec 2.19 deficiencies:
- 16) Concerning the description to generate the CRC table:
 - a) The term "logical shift" is used to describe operations to build the CRC table. A brief description of what is meant by logical shift may be helpful.
 - b) The CRC table is indicated to have 16 entries, but the instructions for completing the table are only applied to 4 entries. An explanation is necessary.

Problem Report Continuation

page 3 of 3

a. Report #: 11

b. Notes/Explanation (Please reference appropriate section number):

17) Concerning the description for calculation the checksum:

- a) The description for calculating the checksum is very vague.
- b) In step 1, the term "first" is used in the checksum calculation; but the byte ordering of the variable BYTE_PACKET is not specified. It is not clear which byte should be used.
- c) In step 3, the instruction does not specify where the result of the operation is to be placed.

GCS Action Report

page 1 of 3

1. AR#: 11.1	2. Planet: Pluto	3. Date of Action: June 7, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
5. Artifact Identification: <input checked="" type="checkbox"/> Design Description Source Code Executable Object Code		Support Documentation Other	Configuration Item: Pluto Design Description P-Spec 2.4 CP
6. Description of Action <p>In addition to addressing the items on PR #11, P-Spec 2.4 CP has been updated to comply with Formal Modification 2.3-2 which addresses functional unit scheduling.</p> <ol style="list-style-type: none"> 1) a) The following data elements have been removed as inputs to P-Spec 2.4: CL, AE_SWITCH, CHECKSUM, FRAME_BEAM_UNLOCKED, FRAME_ENGINES_IGNITED, INTERNAL_CMD, ITH_FRAME_5, ITH_FRAME_2, SWITCH, TDLRSP_SWITCH, TDSP_SWITCH, TE_LIMIT, and THETA. Note, the data element C_STATUS remains as input to P-Spec 2.4 as it is an valid input. b) The following data elements have been removed as outputs from P-Spec 2.4: NBYTES, BYTE_PACKET. 2) The processing specified in P-Spec 2.19 CALCULATE CRC-16 has been moved to P-SPEC 2.4 CP and P-Spec 2.19 removed from the design. 3) The table in question has been removed from the P-Spec. The intended information presented in the table is now presented in the description of the organization of the various data fields. 4) Reporting of the data element K_MATRIX is now consistent with the specifications. The appropriate bit in the data mask is set and only the appropriate elements of the data element K-MATRIX are reported. 5) The bit associated with the data element K_ALT in the data mask is set when generating a data packet for reporting the completion of subframe one. 6) The design has been modified to explicitly show the "packing" of the data element GP_ROTATION. 7) The design has been modified to explicity show the "packing" of every data element into data packets. There is no abiguity as to which data elements are reported and which are not. 8) The cited statements have been removed from the design. 9) See item number 7 above. 			
7. Was the action related to another action(s)? <div style="float: right; text-align: right;"> Yes AR#(s) <input checked="" type="checkbox"/> No Do not know </div>			

Action Report Continuation

page 2 of 3

a. Report #:

11.1

b. Notes/Explanation (Please reference appropriate section number):

- 10) Reference to the data element "sub_frame_counter" has been removed from the P-Spec.
- 11) The data element NBYTES has been removed from the design.
- 12) The control structure of the algorithm has been modified and the cited "ELSE" statement removed.
- 13) Documentation has been added for the CRC-16 function.
- 14) See item number 7 above.
- 15) The requirement to set the status of the communications gear has been moved to the beginning of the processing.
- 16) The function for computing the CRC has been redesigned and now includes a reference and description of the algorithm employed.
- 17) See item 16 above.

While implementing the changes documented above, several modifications to other portions of the design were necessary.

The original P-Spec 2.4 incorrectly contained an output data flow named PACKET which connected to an external terminator named TELEMETRY TRANSMITTER. The actual destination of the output data flow PACKET is the data store EXTERNAL. The context diagram GCS, DFD 0 INIT_RUN_GCS, and DFD 2 RUN_GCS have all been modified to express the correct destination of the data flow named PACKET.

The data store named EXTERNAL has been modified to explicitly reference the appropriate data elements. Previously, EXTERNAL referred to the individual data elements indirectly by referencing named data flows which contained the data elements.

DFD 2 RUN_GCS contained a data store named SUBFRAME_COUNTER_STORE which supplied bubble .4 with the control signal SUBFRAME_COUNTER. The data element SUBFRAME_COUNTER was added to the data flow named COMM_EXT_IN. Bubble .4 now has access to the data element SUBFRAME_COUNTER via the data flow COMM_EXT_IN. The data store SUBFRAME_COUNTER_STORE and the associate flow have been removed from DFD 2 RUN_GCS.

DFD 2 RUN_GCS had a data flow named COMM_RP_IN containing a single input to bubble .4. The data flow has been renamed to COMM_SYNC_PATTERN.

Action Report Continuation

page 3 of 3

a. Report #:

11.1

b. Notes/Explanation (Please reference appropriate section number):

DFD 2 RUN_GCS had a data flow named COMM_GS_IN containing a single input to bubble .4. The data flow has been renamed to C_STATUS.

DFD 2. RUN_GCS contains a data flow named COMM_GS_IN connecting the data store GUIDANCE_STATE to bubble .4. The following data elements have been removed from COMM_GS_IN when addressing item 1 above: AE_SWITCH, CL, FRAME_BEAM_UNLOCKED, FRAME_ENGINES_IGNITED, INTERNAL_CMD, RE_SWITCH, TDLRSP_SWITCH, TDSP_SWITCH, TE_LIMIT and THETA.

The processing formerly specified in P-Spec 2.19 Calculate CRC-16 is now specified within P-Spec 2.4 CP. Bubble .19 representing P-Spec 2.19 and the associated data flows have been removed from DFD 2 RUN_GCS.

GCS Problem Report

page 1 of 3

1. PR #: 12	2. Planet: Pluto	3. Discovery Date: Oct. 15, 1993	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	DR	CR	RC	RS	* Activity TRR	TCR	TCC	TCE	R	O
Design	X									
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The following are inconsistencies and deficiencies for the GP P-Spec. 2.7 in the Pluto Design Description that need to be addressed.

- 1) The comment which lists all the functions of the P-Spec. is incomplete.
- 2) Local "real" variables declared with inadequate precision.
- 3) The description for shifting variables with history dimension uses ambiguous notations. Further, G_ROTATION is incorrectly listed as having a history dimension.
- 4) Concerning the description of calculations for GP_ATTITUDE, GP_VELOCITY, and GP_ALTITUDE:
 - a) A mixture of array index notations is used in describing making it unclear exactly which element of the arrays are involved in the calculations.
 - b) The assignment operator, "=", is not used consistently with its definition.
 - c) The description of calculation does not accommodate for solving the equations simultaneously as indicated in Appendix C.
- 5) The description for the set up of the GP_ROTATION MATRIX is inadequate.

7. Artifact Identification:

☒ Design Description
☐ Source Code
☐ Executable Object Code

☐ Support Documentation
☐ Other

Configuration Item:
Pluto Design Description

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
6/9/94		Angellatta		12.1
	6/20/94	Quach		
6/20/94	6/20/94	Hayhurst		

10. Total # of Changes: 13

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by
 Patrick Quach

6-20-94

13. SOA Signature & Date

Original Signed by
 Kelly Hayhurst

6/20/94

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 3

a. Report #: 12

b. Notes/Explanation (Please reference appropriate section number):

- 6) In reference to range checking:
 - a) GP_PHASE is unnecessary checked for limits.
 - b) GP_ALTITUDE lower limit check is incorrect
 - c) Limit checking for the following is missing:
 - GP_ATTITUDE,
 - A_ACCELERATION,
 - AR_ALTITUDE,
 - G_ROTATION,
 - TE_INTEGRAL,
 - GP_ROTATION
- 7) Concerning the IF block for GP_PHASE = 1:
 - a) The data element "tnow" is used in the first IF block for GP_PHASE but not defined.
 - b) FRAME_ENGINES_IGNITED limit check is unnecessary and incorrect.
 - c) Limit checks for the following are unnecessary:
 - AE_TEMP
 - CHUTE_RELEASED
 - TDS_STATUS
 - TD_SENSED
 - d) Limit check for GP_VELOCITY inside this if block implies that limits for this variable is only checked for 1 GP_PHASE.
- 8) The combined processing of engine on/off status determination and terminal descent phase determination makes requirements from the GCS Spec very difficult to trace. The processing is also incorrect.
- 9) Concerning the description for pre-indexing into the CONTOUR_VELOCITY array:
 - a) The description does not give any indication into why it is being done.
 - b) The CONTOUR_VELOCITY array is the wrong one to index into.
 - c) No algorithmic solution is given.
 - d) The description uses the variable "size" which is not declared.
 - e) No bounding limits are given for the binary search.
- 10) A description for proportional extrapolation and the pseudo-code that follows is not clear.
- 11) Concerning the description for calculating the VELOCITY_ERROR:
 - a) The description is nested inside a condition when it should be performed unconditionally.
 - b) The description for computing VELOCITY_ERROR is incorrect.
- 12) Limits checking for CL is unnecessary.
- 13) In determining which control laws to use,
 - a) Ambiguous notation used to index into GP_VELOCITY array
 - b) The condition "VELOCITY_ERROR > 0" in the IF statement a convoluted way of specifying the same thing as the Spec. It is difficult to trace to the Spec.
 - c) The variable "optimal_velocity" is used here but no value has been previously assigned to it. It has not even been declared.
- 14) The note describing the GP_ATTITUDE, GP_VELOCITY, AND GP_ALTITUDE references section 2.7 of the Spec. for variable definitions. The variable definitions are no longer in section 2.7 of the Spec.

Problem Report Continuation

page 2 of 3

a. Report #: 12

b. Notes/Explanation (Please reference appropriate section number):

- 15) The equations given for the derivatives do not provide sufficient detail to be translatable into code. Generators to variables are all indexed as single dimensional while some variables have 3 dimensions.

GCS Action Report

page 1 of 2

1. AR#: 12.1	2. Planet: Pluto	3. Date of Action: June 16, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
5. Artifact Identification: X Design Description Source Code Executable Object Code		Support Documentation Other	Configuration Item: Pluto Design Description P-Spec 2.7 GP
6. Description of Action 1) The initial comment which enumerates the responsibilities of this functional unit has been modified to include all of responsibilities of GP. 2) Since this is a design, and not code, references to the data types have been removed from the P-Spec. 3) The "rotate variables" algorithm has been replaced and now explicitly describes the concept of "shifting." 4) The description for computing the current values of GP_ATTITUDE, GP_VELOCITY, and GP_ALTITUDE has been rewritten. 5) The description of the construction of GP_ROTATION is now very explicit. 6) a) Range checking for GP_PHASE has been removed from the P-Spec. b) The lower limit for GP_ALTITUDE has been corrected. c) Range checking for the appropriate data elements has been specified. 7) The cited "IF block" has been totally respecified. 8) In conjunction with item 7, the processing of the engine on/off has been totally respecified for clarity. 9) The computation of the "optimal_velocity" has been completely respecified. The interpolation and expolation algorithms are presented. 10) See item 9. 11) The computation of the velocity error has been completely respecified. 12) Range checking for CL has been removed from the P-Spec. 13) The processing which determines which set of control laws to use has been completely respecified.			
7. Was the action related to another action(s)? <div style="text-align: right;"> Yes AR#(s) X No Do not know </div>			

Action Report Continuation

page 2 of 2

a. Report #:

12.1

b. Notes/Explanation (Please reference appropriate section number):

14) The notes describing the processing of GP_ATTITUDE, GP_VELOCITY, and GP_ALTITUDE have been rewritten and moved to the appropriate section of the "Design Overview."

15) See item 14.

GCS Problem Report

page 1 of 4

1. PR #: 13	2. Planet: Pluto	3. Discovery Date: Oct. 15, 1993	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design	X									
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The following are deficiencies in the Data Dictionary, Data Flow Diagrams, and Process Activation Tables of the Pluto Design Description.

DATA DICTIONARY deficiencies

- 1) Incomplete/Incorrect aggregate data flow
 - a) The actual data elements in the EXTERNAL data store do not agree with those in the Spec..
 - b) COMM_EXT_IN is missing the variable SUBFRAME_COUNTER.
 - c) CHUTE_RELEASE data/control flow contains data not included in the Spec. The only field specified in the Spec for this data flow is CHUTE_RELEASED.
 - d) COMM_GS_IN contains C_STATUS and CL which are not inputs to CP.
 - e) INIT_GS_OUT
 - has 2 extra data flows not defined as part of GUIDANCE_STATE data store in the Spec. They are TDLRSP_SWITCH and TDSP_SWITCH.
 - is missing the variable CL
 - f) GUIDANCE_STATE_DATA has extra variables TDLRSP_SWITCH and TDSP_SWITCH

7. Artifact Identification:

<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:
<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	Pluto Design Description
<input type="checkbox"/> Executable Object Code		

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
6/21/94		Angellatta		13.1
	6/27/94	Quach		
6/27/94	6/28/94	Hayhurst		

10. Total # of Changes: 19

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by
Patrick Quach

6-27-94

13. SOA Signature & Date

Original Signed by
Kelly Hayhurst

6/28/94

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 4

a. Report #: 13

b. Notes/Explanation (Please reference appropriate section number):

- 2) Data Store Inconsistencies:
- a) Extra variables in GUIDANCE_STATE data store:
CHUTE_RELEASE
TDLRSP_SWITCH
TDSP_SWITCH
 - b) The GENERATE_SEQUENCE_PARMS store is not defined and not used.
- 3) Incorrect/Incomplete DATA DICTIONARY definitions
- a) TDLR_ANGLES, "PI" is used in the RANGE field but not defined.
 - b) THETA, "PI" is used in the RANGE field but not defined.
 - c) AR_FREQUENCY, the RANGE upper value "2.45**9" is incorrect.
 - d) BYTE_PACKET is defined to be 188 of Integer*1 which does not match its usage as a temporary variable for PACKET which is 256 of Integer*2
 - e) CHECKSUM definition is not complete
 - f) INIT_END_GCS - if a control flow can only deliver one value, why have it.
 - g) INIT_EXT_OUT - inadequate description!
 - h) NBYTES - inadequate description!
 - i) RENDEZVOUS_CNIL - inadequate description!
 - j) RUN_GCS - inadequate description!
 - k) ITH_FRAME_2 - inadequate description!
 - l) ITH_FRAME_5 - inadequate description!
 - m) INIT_SUBFRAME_COUNTER - set to "1" with no explanation.
 - n) START_GCS - inadequate description leaves PAT open for interpretation.
- 4) Unused data flows:
- | | |
|--------------------|-------------------------|
| AECLP_DONE, | ARSP_DONE |
| ASP_DONE, | CLP_DONE |
| CP_DONE, | CRCP_DONE |
| GP_DONE, | GSP_DONE |
| RECLP_DONE, | RENDEZVOUS |
| SP_DONE, | TDLRSP_DONE |
| TDSP_DONE, | TSP_DONE |
| EXTERNAL_OLD, | GUIDANCE_STATE_OLD |
| INIT_GCS, | GENERATE_SEQUENCE_PARMS |
| RUN_GCS, | RUN_PARAMETERS_OLD |
| SENSOR_OUTPUT_OLD, | COMM_EXT_OUT |
| TDLRSP_SWITCH, | TDSP_SWITCH |
- 5) Unnecessary renaming of another data flow:
- | | |
|-------------------|------------------|
| ACCEL_EXT_IN, | ACCEL_GS_IN |
| ACCEL_GS_OUT, | ACCEL_SO_OUT |
| ALT_RAD_RP_IN, | ALT_RAD_SO_IN |
| ALT_RAD_SO_OUT, | AX_ENG_EXT_IN |
| AX_ENG_EXT_OUT, | AX_ENG_SO_OUT |
| CHUTE_REL_GS_OUT, | COMM_GS_OUT |
| COMM_RP_IN, | EXTERNAL_DATA |
| GUIDE_EXT_IN, | ROL_ENG_EXT_OUT |
| TD_GS_OUT, | TD_LND_RAD_SO_IN |
| TD_LND_RAD_SO_OUT | |

Problem Report Continuation

page 3 of 4

a. Report #: 13

b. Notes/Explanation (Please reference appropriate section number):

- 6) END_GCS control flow is no longer an output of GP.
- 7) SUBFRAME_COUNTER_STORE is unnecessary. The control flow emanating there from is already included in COMM_EXT_IN.
- 8) It is not clear from available documentation how the following stores are used:
 - *END_GCS_STORE
 - *GP_HAS_RUN_STORE
 - *RENDEZVOUS_CNTL_STORE
 - *SUBFRAME_COUNTER_STORE

CONTEXT DFD deficiencies

- 1) In the context DFD, the data for FRAME_COUNTER and SUB_FRAME_COUNTER are not shown returning to the external entity GCS_SIM INIT AND RENDEZVOUS. These data flows are missing from the next level DFD.
- 2) The data flow INITIALIZATION_DATA contains a control flow variable.

DFD 2 deficiencies

- 1) Some bubbles have identical data flow in and out of the bubbles. This violates SA conventions. The specific data flows are:
 - Bubble 2.12: EXTERNAL_DATA, FRAME_COUNTER
 - Bubble 2.13: RAW_SENSOR_DATA, RAW_SENSOR_EXT_OUT
 - Bubble 2.14: RUN_PARAMETER_DATA, INIT_RP_OUT
 - Bubble 2.15: GUIDANCE_STATE_DATA, INIT_GS_OUT
 - Bubble 2.16: CHUTE_RELEASE
 - Bubble 2.17: AE_RE_CMDS, ENGINE_DATA
- 2) Bubble 2.18, COPY CONTROL DATA, does not perform any discernible data processing. It is extraneous.
- 3) In DFD-2 It is not clear that the PACKET data flow goes into the GUIDANCE_STATE data store as indicated by the Spec

PAT INIT_RUN_GCS deficiencies

- 1) The second line shows bubble numbers but can easily be confused as additional execution orders to control execution. The same thing occurs in the PAT for DFD-2.
- 2) The fifth line shows that the order of activation of GENERATE_SEQUENCE_PARMS and RUN_GCS doesn't matter; however, the INIT_END_GCS DFD shows that for a given frame, GENERATE_SEQUENCE_PARMS must be executed before RUN_GCS because the variables ITH_FRAME_2 and ITH_FRAME_5 flow from GENERATE_SEQUENCE_PARMS to RUN_GCS.

Problem Report Continuation

page 4 of 4

a. Report #: 13

b. Notes/Explanation (Please reference appropriate section number):

PAT RUN_GCS deficiencies

- 1) The process "COPY CONTROL DATA" is missing from this PAT leaving its activation order unknown.
- 2) For the cases where subframe_counter = 1, the PAT imposes a constraint on processes that do not depend on TSP.
- 3) For the cases where subframe_counter = 3, the PAT imposes an order constrain on execution of AECLP, and RECLP.
- 4) The SUBFRAME_COUNTER is assign a new value in this PAT. This is incorrect.
- 5) The control variables ITH_FRAME_2 and ITH_FRAME_5 should be removed to reflect new changes in the Spec. Process activation order should also be changed accordingly.
- 6) The simulator rendezvous is activated at the end of each subframe. It is however missing from the activation order in the table.
- 7) In the column GP_HAS_RUN, use of the "DONT CARE" value is not clearly interpretable.
- 8) The processes SEND CHUTE RELEASE COMMAND and SEND ENGINE DATA do not perform any data transformation and hence should be removed from the activation list.

GCS Action Report

page 1 of 2

1. AR#: 13.1	2. Planet: Pluto	3. Date of Action: June 24, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
5. Artifact Identification: X Design Description Source Code Executable Object Code		Configuration Item: Support Documentation Other Pluto Design Description	
<p>6. Description of Action</p> <p>Data Dictionary deficiencies</p> <ol style="list-style-type: none"> 1) The four data stores EXTERNAL, GUIDANCE_STATE, RUN_PARAMETERS, and SENSOR_OUTPUT has been modified as necessary to be consistent with the GCS Software Requirements. The named data flows connecting the four data stores with processes have been modified to include only the necessary data items. All spurious data stores have been removed from the design. 2) Refer to item 1 above. 3) A value has been assigned to "PI" where necessary. The value for the upper limit of the data element "AR_FREQUENCY" has been modify. The data elements cited in d) through n) have been removed from the design. 4) The cited unused data elements have been removed from the design. 5) All of the cited data/control flows 'renamed' a single data element exiting in one of the four data stores. In such cases, the 'renaming' data/control flow was removed from the data dictionary and replaced in the DFDs by the single element it represented. 6) The 'END_GCS' control flow serves as a 'halt' signal for the implementation and does originate from the process named 'GP'. 7) Refer to item 1 above. 8) Refer to item 1 above. <p>Context DFD deficiencies</p> <ol style="list-style-type: none"> 1) The data element FRAME_COUNTER does not explicitly appear in the modified context DFD. The data element SUB_FRAME_COUNTER has been removed from the design. 2) The data flow INITIALIZATION_DATA has been removed from the design. 			
<p>7. Was the action related to another action(s)?</p> <div style="text-align: right;"> Yes AR#(s) X No Do not know </div>			

Action Report Continuation

page 2 of 2

a. Report #:

13-1

b. Notes/Explanation (Please reference appropriate section number):

DFD 2 deficiencies

- 1) All of the cited processes have been removed from the design.
- 2) The cited process has been removed from the design.
- 3) The design has been modified to clearly depicted the data element 'PACKET' resides in the data store 'GUIDANCE_STATE.'

PAT INIT_RUN_GCS deficiencies

- 1) The second line indicating the process numbers is an appropriate process specification for a PAT under Teamwork. Note, however that they have been removed from the modified design.
- 2) The process 'GENERATE_SEQUENCE_PARAMS' has been removed from the design.

PAT RUN_GCS deficiencies

- 1) The process 'COPY_CONTROL_DATA' has been removed from the design.
- 2) It is inherent in the design process to impose constraints upon the abstractions presented in the requirements specifications. There is no deficiency indicated in item 2.
- 3) Refer to item 2 above.
- 4) The design has been modified and does not assign a value to the data element 'SUBFRAME_COUNTER'.
- 5) The control flows 'ITH_FRAME_2' and 'ITH_FRAME_5' have been removed from the design.
- 6) The design has been extensively modified to indicated to proper activation of the process named 'GCS_SIM_RENDEZVOUS,' the simulator rendezvous processing.
- 7) The control flow 'GP_HAS_RUN' has been removed from the design.
- 8) The processes 'SEND_CHUTE_RELEASE_COMMAND' and 'SEND_ENGINE_DATA' have been removed from the design.

GCS Problem Report

page 1 of 1

1. PR #: 14	2. Planet: Pluto	3. Discovery Date: Jun. 27, 1994	4. Initiator & Role: Designer/Angellatta
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design	<i>16/1</i>									✓
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

*SPEC MOD * 2.3-2*

6. Description of Problem:

The scheduling algorithm for functional units has ⁵ been changed by Formal Modification 2.3-2. The functional units ARSP and TDLRSP must be modified so that they are consistent with the new scheduling requirements.

7. Artifact Identification:

<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:
<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	Pluto Design Description
<input type="checkbox"/> Executable Object Code		P-Specs 1.2 (ARSP)
		1.5 (TDLRSP)

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
6/28/94	6/28/94	Angellatta		14.1
6/28/94		Quach		
6/29/94	6/29/94	Hayhurst		

10. Total # of Changes: 4

11. Total # of No Changes:

2. Initiator: Signature & Date

13. SOA Signature & Date

Original Signed by

June 29, 1994

Original Signed by

6/29/94

* At Rob Angellatta

de Review; RC - Reading Code; RS - Reading Kelly Hayhurst

review; TCR - Test Completion Review;

TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

GCS Action Report

page 1 of 1

1. AR#: 14.1	2. Planet: Pluto	3. Date of Action: June 28, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
5. Artifact Identification: <input checked="" type="checkbox"/> Design Description Source Code Executable Object Code		Support Documentation Other	Configuration Item: Pluto Design Description ARSP and TDLRSP
6. Description of Action <p>Formal Modification 2.3-2 changed the functional unit scheduling algorithm. This has a direct impact upon the processes ARSP and TDLRSP, which had been modified prior to the issuance of Formal Modification 2.3-2.</p> <p>Changes to ARSP.</p> <p>All references to "odd" and "even" frames and "normal" and "alternate" processing have been removed from the P-Spec. The control statement which formerly determined "normal" and "alternate" processing has also been removed from the P-Spec. The algorithm for computing the current altitude by fitting a polynomial to the four previously computed values for the altitude had been optimized to use only two of the previous values. This algorithm has been modified to use all four previous values. A few minor syntax changes were made in order to make the syntax of this P-Spec consistent with more recently edited P-Specs.</p> <p>Changes to TDLRSP.</p> <p>All references to "odd" and "even" frames and "normal" and "alternate" processing have been removed from the P-Spec. The control statement which formerly determined "normal" and "alternate" processing has also been removed from the P-Spec.</p>			
7. Was the action related to another action(s)? Yes AR#(s) <input checked="" type="checkbox"/> No Do not know			

GCS Problem Report

page 1 of 2

1. PR #: 15	2. Planet: Pluto	3. Discovery Date: July 13, 1994	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design	X									
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The following are inaccuracies/deficiencies for the functional units in the sensor processing subframe.

ARSP, P-Spec 1.2

- 1) FRAME_COUNTER is not an input to this process. This is probably due to an error in the specification.
- 2) Range Checking is not performed for AR_ALTITUDE history variables that are used in the Divided Difference calculation.
- 3) It is not necessary to use FORTRAN floating point notation for a constant in the design.

ASP P-Spec 1.3

- 1) The check made for negative arguments under the square root is insufficient.

7. Artifact Identification:

<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item: Pluto Design Description, P-Specs 1.2, 1.3, 1.5, and 1.7
<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	
<input type="checkbox"/> Executable Object Code		

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
7/18/94	7/21/94	Angellatta		15.1
7/21/94	7/21/94	Quach		
7/21/94	7/21/94	Hayhurst		

10. Total # of Changes: 11

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by Patrick Quach 7-21-94

13. SOA Signature & Date

Original Signed by Kelly Hayhurst 7/21/94

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 2

a. Report #: 15

b. Notes/Explanation (Please reference appropriate section number):

Section 6. Description of Problem (continued):

- 2) Range Checking is not performed for A_ACCELERATION history variables that are used in the mean and standard deviation calculation.

TDLRSP, P-Spec 1.5

- 1) The design has not explicitly stated the number of radar beams.
In reference to the start of the DO loop:

do (for each radar beam l)
- 2) Concerning the set of IF statements for determining radar beam states (pg. 4) The design meets all the requirements but has extra branches that are not specified in the Requirements.
- 3) The setting of the off-diagonal elements of K_MATRIX to zero is not necessary.
- 4) Below the table for determining process beam velocity, equation b) has a typo for the operator in front of the term b(4). This also occurs in case #15 of the subsequent case statement.

TSP, P-Spec 1.7

- 1) Concerning the Lower parabolic function (pg. 3):
There is a typo in the substitution of "h" into the parabolic equation. Either there is an extra set of paren. or the sign after the M3 should be a "+"
- 2) There is a typo in the first equation in the derivation for the upper parabolic region. Particularly, the "y = 4*p..." should be "y = 1/(4*p)..."

GCS Action Report

page 1 of 2

1. AR#: 15.1	2. Planet: Pluto	3. Date of Action: July 20, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
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5. Artifact Identification: <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><input checked="" type="checkbox"/> Design Description</p> <p>Source Code</p> <p>Executable Object Code</p> </div> <div style="width: 45%;"> <p>Support Documentation</p> <p>Other</p> </div> </div>	Configuration Item: <p>Pluto Design Description</p> <p>P-Specs 1.2, 1.3, 1.5, and 1.7</p>
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6. Description of Action

ARSP

- 1) The data element FRAME_COUNTER has been removed from the input list to the P-Spec ARSP and from the data flow named ARSP_EXT_IN. Removing FRAME_COUNTER from the data flow ARSP_EXT_IN reduces the data flow to a single data element AR_COUNTER. So, the data flow named ARSP_EXT_IN has been removed from the data dictionary and replaced in DFD 1 with the data flow AR_COUNTER. It is not clear why this item is listed as a deficiency of the design as the most recently released GCS Software Specification, version 2.3-3.3 clearly identifies the data element FRAME_COUNTER as an input to ARSP.
- 2) Range checking for the data element AR_ALTITUDE has been added where necessary.
- 3) The FORTRAN notation for the constant value 3×10^8 has been replaced with the notation "3x10^8".

ASP

- 1) A check for a negative value has been added before performing the square root operation. It is not clear why the absence of the check is a deficiency of the design.
- 2) Range checking for the data element A_ACCELERATION has been added as appropriate.

TDLRSP

- 1) A reference to the number of beams to be processed has been added to the "do loop" specifications.
- 2) The "extra branches" have been removed from the radar beam state processing.
- 3) Processing of the off-diagonal elements of K_MATRIX has been removed.
- 4) The formula for computing "pbvY" has been corrected in both the description of processing the beam velocities and in the expression of

7. Was the action related to another action(s)?	<p>Yes AR#(s)</p> <p><input checked="" type="checkbox"/> No</p> <p>Do not know</p>
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Action Report Continuation

page 2 of 2

a. Report #:

15.1

b. Notes/Explanation (Please reference appropriate section number):

the algorithm. The correct formula is: $pbvY = (b(1) - b(2) - b(3) + b(4)) / 4$.

TSP

- 1) The formula representing the lower parabolic function has been corrected by rewriting the formula such that it is now consistent with it's description. The correct formula is: $lower-parabolic-temp-function = -(x - (M3 + (((T4 - T3) / (M4 - M3)) / 2)))^2 + (T3 + (((T4 - T3) / (M4 - M3)) / 2^2))$.
- 2) In the derivation of the formula representing the upper parabolic function, the general equation of a parabola has been corrected by rewriting the equation. The correct equation is: $y = 1 / (4 * p) * (x - h)^2 + k$.

GCS Problem Report

page 1 of 2

1. PR #: 16	2. Planet: Pluto	3. Discovery Date: July 13, 1994	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design	X									
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The following are inaccuracies/deficiencies for the functional units in the control law processing subframe and the Communications Processing functional unit.

RECLP, P-Spec 3.4

- 1) pages 3&4, deriving roll engine command:
 - a) Setting RE_CMD for cases where THETA = 0 are incorrect. Specifically:
 - THETA = 0 and $P > P2$ and $P \leq P4$
 - THETA = 0 and $P \leq P2$ and $P > P1$
 - THETA < 0 and THETA \geq -THETA1 and $P < -P2$
 - THETA < 0 and THETA \geq -THETA1 and $P = -P2$
 - b) For the case where:
 - THETA \geq -THETA & G_ROTATION < -P2,
 the value of RE_CMD does not agree with the comment describing the values
 - c) On page 4 - When checking the ranges in the "-THETA2" region - the following is incorrect. else if (THETA \geq THETA2) then

7. Artifact Identification:

<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item: Pluto Design Description P-Specs 1.8, 2.2, 2.3, and 2.4 3.2, 3.3, and 3.4 <i>KJH</i>
<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	
<input type="checkbox"/> Executable Object Code		

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
7/21/94	7/22/94	Angellatta		16.1
7/22/94	7/22/94	Quach		
7/22/94	7/22/94	Hayhurst		

10. Total # of Changes: 14

11. Total # of No Changes:

12. Initiator Signature & Date

Original Signed by
Patrick Quach

7-22-94

13. SOA Signature & Date

Original Signed by
Kelly Hayhurst

7/22/94

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 2

a. Report #: 16

b. Notes/Explanation (Please reference appropriate section number):

Section 6. Description of Problem (continued):

AECLP, P-Spec 3.2

- 1) The if statements that implement table 5.1 do not specify the correct order of operation in two instances of the following: (according to Fortran evaluation rules)
IF (FRAME_COUNTER - FRAME_ENGINES_IGNITED * DELTA_T <...
- 2) Yaw_error_limit equation (pg. 7)
In the yaw_error_limit equation: "GQ" is not the correct gain.
- 3) Processing step enumeration (pg. 7-10)
The enumeration of step "2C" on the middle of page 7 duplicates the previous numbering. This step should be "2D". Subsequent steps are also off by 1 letter.
- 4) The value of "e" (pg. 9)
Typo in the value of "e"
e = 2.718281828459045235360.....
- 5) Concerning setting of AE_CMD from INTERNAL_CMD (pg. 11)
In the second branch of all 3 "If" statements (as shown below), the inequality is incorrect
"(INTERNAL_CMD(I) < 1)"

CRCP, P-Spec 3.3

- 1) Limit checking (pg. 1)
Limits checking is not necessary for CHUTE_RELEASED and AE_TEMP.
- 2) The variable assignment (pg. 1) for CHUTE_RELEASED is unclear.

CP, P-Spec 1.8

- 1) The record and pointer notation is not clearly explained
- 2) Concerning the CRC table:
 - a) An algorithm description would aid verification.
 - b) The design is not clear about the number of bits in the CRC
- 3) The first subscript for K_MATIRX (pg. 7) in the following is incorrect:
DATA_PACKET.data.sp.k_matrix(3) = K_MATRIX(2,3,0)
- 4) In the following:
Index = crc XOR next_byte
the design has not stated that only the low-order byte of crc is to be used.

GCS Action Report

page 1 of 2

1. AR#: 16.1	2. Planet: Pluto	3. Date of Action: July 21, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
5. Artifact Identification:		Configuration Item:	
<input checked="" type="checkbox"/> Design Description Source Code Executable Object Code		Support Documentation Other Pluto design description P-Specs 1.8, 2.2, 2.3, and 2.4	
6. Description of Action			
<input checked="" type="checkbox"/> RECLP			
<p>1a) A new case was added to the processing which determines the roll engine commands. The new case addresses the instance when THETA is equal to zero. The existing case which use to handle the condition when THETA is greater than or equal to zero has been altered to handle the condition when THETA is greater than zero.</p> <p>1b) The roll engine command for the case where $THETA \geq -THETA$ and $G_ROTATION < -P2$, is Maximum Counterclockwise. A comment indicated the correct command for this condition, however an improper value was generated in the algorithm. The algorithm has been modified to assign the proper value.</p> <p>1c) The intended condition for evaluation is $THETA \geq -THETA2$. The negative sign was inadvertently missing from the expression. The expression has been corrected by adding the negative sign to $THETA2$.</p> <p>AECLP</p> <p>1) There are two instances of the expression: if (FRAME_COUNTER - FRAME_ENGINES_IGNITED * DELTA_T < ...) . The correct expression is: if ((FRAME_COUNTER - FRAME_ENGINES_IGNITED) * DELTA_T < ...), the subtraction must occur before the multiply. These instances have been update with the correct expression.</p> <p>2) The formula for computing the yaw_error_limit incorrectly contains the data element "GQ". The correct data element "GR" has been substituted for "GQ" in the equation.</p> <p>3) The "steps" have been renumbered beginning with the second step 2C.</p> <p>4) The value of e has been modified to the value 2.718281828459045.</p> <p>5) The processing for computing the value of AE_CMD has three instances of the expression if (INTERNAL_CMD(.) < 1) then, the proper expression is if (INTERNAL_CMD(.) <= 1). These three instances have been updated with the correct expression.</p>			
7. Was the action related to another action(s)?		Yes AR#(s) <input checked="" type="checkbox"/> No Do not know	

Action Report Continuation

page 2 of 2

a. Report #:

16.1

b. Notes/Explanation (Please reference appropriate section number):

✓CRCP

1) CRCP has been totally written in accordance with the style of the other P-Specs. The limit checks for the data elements CHUTE_RELEASED and AE_TEMP have been removed from the processing.

2) The computation of the data element CHUTE_RELEASED has been rewritten and is now very explicit.

CP

1) The notation for the record and pointer syntax will be clearly described in the "overview" section of the design. A few comments have been added to this P-Spec to help clarify the notation.

2) A comment has been added to the CRC processing citing a reference which contains the algorithm for constructing the table. Also, several comments have been added with clearly indicate the number of bits being processed in the CRC.

3) When building the data packet for the sensor processing subframe, the data element K_MATRIX(2,3,0) was inadvertently packed into the buffer twice. Actually, the second occurrence of K_MATRIX(2,3,0) should have referenced K_MATRIX(3,3,0). The second occurrence has been modified to the appropriate expression.

4) Several comments have been included which explicitly indicate the number of bits, either lower 8 bits or all 16 bits, being operated on during the XOR operations.

GCS Problem Report

page 1 of 2

1. PR #: 17	2. Planet: Pluto	3. Discovery Date: July 13, 1994	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design	X									
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The following are inaccuracies/deficiencies in the data flow diagrams and data dictionary.

STRUCTURED ANALYSIS DIAGRAMS

- 1) GCS Context Diagram
PACKET does not appear on any flow going out from the bubble GCS to the telemetry external sink.
- 2) GCS DFD/CFD
PACKET does not appear on flows coming from each of the three subframe bubbles and going off-page.
- 3) Sensor Processing Subframe DFD/CFD
PACKET does not appear on a flow out from GCS_SIM_RENDEZVOUS to off-page connector.
- 4) Guidance Processing Subframe DFD/CFD
PACKET does not appear on a flow out from GCS_SIM_RENDEZVOUS to off-page connector.

7. Artifact Identification:

<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:
<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	Pluto Design Description, Context Diagram, DFD 0, 1, 2, 3, and Data Dictionary
<input type="checkbox"/> Executable Object Code		

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
7/22/94		Angellatta		17.1
	7/28/94	Quach		
7/28/94	7/29/94	Hayhurst		

10. Total # of Changes: 7

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by
Patrick Quach

7-28-94

13. SOA Signature & Date

Original Signed by
Kelly Hayhurst

7/22/94

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 2

a. Report #: 17

b. Notes/Explanation (Please reference appropriate section number):

Section 6. Description of Problem (continued):

- 5) Control Law Processing Subframe DFD/CFD
- a. PACKET does not appear on a flow out from GCS_SIM_RENDEZVOUS to off-page connector.
 - b. The data flow coming from GUIDANCE_STATE to AECLP does not include INTERNAL_CMD, but it is an input to AECLP. (Note: this is a result of Formal Modification 2.3-3.2)

Data Dictionary

- 1) Ordering of data element is important for interoperability with GCS_SIM_RENDEZVOUS but is not specified in the data store definitions.
- 2) For data element, CL, the range does not correspond to its TeamWork usage.
- 3) The data element, END_GCS, is missing a description.
- 4) The group flow, GP_GS_IN, includes TE_INTEGRAL which is not an input to GP.
- 5) Typo in the following primitive data elements:

CONTOUR_CROSSED	DESCRIPTION field	should be "...velocity-altitude..."
G1	UNITS field	should be "(meters/sec^2)/(degree_C)"
G2	UNITS field	should be "(meters/sec^2)/degree_C^2"
GVEI	UNITS field	should be "/sec^2"
K_MATRIX	ACCURACY field	Spec. has "N/A".
TDLR_ANGLES	DESCRIPTION field	"y" should be "gamma"
	RANGE field	PI/2 should be excluded
TE_DROP	DESCRIPTION field	format error
- 6) The hexadecimal notation used in COMM_SYNC_PATTERN is only described in the P-Spec.

GCS Action Report

page 1 of 2

1. AR#: 17.1	2. Planet: Pluto	3. Date of Action: July 27, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
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5. Artifact Identification:	Configuration Item:
<input checked="" type="checkbox"/> Design Description <input type="checkbox"/> Source Code <input type="checkbox"/> Executable Object Code	Support Documentation Other Pluto Design Description

6. Description of Action

Diagrams

- 1) A data flow labeled PACKET has been added to DFD Context-Diagram depicting the data element PACKET flowing between the GCS process and and external device named COMMUNICATOR. A data flow labeled PACKET has also been added to DFD 0, DFD 1, DFD 2, and DFD 3. The output lists of P-Specs 1.1, (1.2), and (1.3) where all modified to include the data element PACKET.
- 2) See item 1.
- 3) See item 1.
- 4) See item 1.
- 5) a) See item 1. b) The data flow AECLP_GS_IN was modified to include the data element INTERNAL_CMD. P-Spec 3.2 was modified to include the data element INTERNAL_CMD as an input.

Data Dictionary

- 1) The SA tool does not provide a method for specifying the ordering of elements within a data store. However, a comment was entered in each of the data stores: EXTERNAL, GUIDANCE_STATE, RUN_PARAMETERS, and SENSOR_OUTPUT indicating the proper ordering of the data elements.
- 2) The range of the data element CL has been modified from the incorrect specification ["0" | "1"] to the correct specification ["1" | "2"].
- 3) The control flow END_GCS will be removed from the design during the processing of PR #18.
- 4) The data element TE_INTEGRAL has been removed from the data flow GP_GS_IN. The data element TE_INTEGRAL has been removed from the input list of P-Spec 2.2.
- 5) The phrase "velocity_altitude" has been changed to "velocity-altitude" in the data dictionary entry for CONTOUR_CROSSED. The phrase "meters/sec^2" has been changed to "(meters/sec^2)/(degree_C)"

7. Was the action related to another action(s)?	Yes AR#(s)
	<input checked="" type="checkbox"/> No
	<input type="checkbox"/> Do not know

Action Report Continuation

page 2 of 2

a. Report #:

17.1

b. Notes/Explanation (Please reference appropriate section number):

in the data dictionary entry for G1. The phrase "(meters/sec^2)/(degree*C^2" has been changed to "(meters/sec^2)/degree_C^2" in the data dictionary entry for G2. The phrase "/second**2" has been changed to "/sec^2)" in the data dictionary entry for GVEI. The phrase "TBD" has been changed to "N/A" in the data dictionary entry for K_MATRIX. The phrase "y" has been changed to "gamma" in the data dictionary entry for TDLR_ANGLES. The phrase "[0, PI/2]" has been changed to "[0, PI/2)" in the data dictionary entry for TDLR_ANGLES. A carriage return was added to the "description" field of the data dictionary entry TE_DROP. A comment has been added to the data dictionary entry COMM_SYNC_PATTERN indicating the use of hexadecimal notation.

(0)

GCS Problem Report

page 1 of 2

1. PR #: 18	2. Planet: Pluto	3. Discovery Date: July 13, 1994	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design	X									
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The following are inaccuracies/deficiencies in the guidance processing subframe.

- 1) TE_INTEGRAL is not an input to this process.
- 2) In the text which describes the 5 step RK method for calculating attitude, velocity, and altitude, clarification is needed on which history variable is being used in the derivative calculation
- 3) In the implementation notes for the RK method, the incorrect variable, GP_ROTATION, is used for calculating GP_ATTITUDE and GP_VELOCITY.
- 4) In the setting of the GP_ROTATION matrix, the wrong history subscript is being used for the G_ROTATION elements.

7. Artifact Identification:

☒ Design Description
☐ Source Code
☐ Executable Object Code

☐ Support Documentation
☐ Other

Configuration Item:

Pluto Design Description, P-Spec 2.2

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
7/29/94		Angellatta		18.1
	7/2/94	Quach		
8/2/94	8/2/94	Hayhurst		

10. Total # of Changes: 7

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by
 Patrick Quach

8-2-94

13. SOA Signature & Date

Original Signed by
 Kelly Hayhurst

8/2/94

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 2

a. Report #: 18

b. Notes/Explanation (Please reference appropriate section number):

Section 6. Description of Problem (continued):

- 5) In each case there is no check for a negative argument before the square root is taken.
- 6) In several instances of divide-by-zero checking, there are extra output from error messages that can not be traced to the Requirements. The text in question is:
"COMPUTATION OF OPTIMAL VELOCITY"
- 7) In reference to the following IF statement in page 8:

 if ((CONTOUR_ALTITUDE == 0) .or. (index == 100)) then

 a) CONTOUR_ALTITUDE is a vector but has no subscript.
 b) the variable index is undefined.
- 8) The overview states that "END_GCS would not be implemented". If that is the case, it should not be shown inside a P-Spec..

GCS Action Report

page 1 of 2

1. AR#: 18.1	2. Planet: Pluto	3. Date of Action: Aug 1, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
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5. Artifact Identification:

X Design Description	Support Documentation	Configuration Item:
Source Code	Other	Pluto Design Description,
Executable Object Code		P-Spec 2.2

6. Description of Action

- 1) In PR #17, the data dictionary section item #4, the data element TE_INTEGRAL was removed from the input list of P-Spec 2.2.
- 2) The description of the 5 step RK method employed for computing the attitude, velocity, and altitude has been modified to include a more detailed description of the computation of derivatives.
- 3) Here is a problem. The data element GP_ROTATION is not contained in the input list for the P-Spec 2.2 GP. Thus, the contents of GP_ROTATION ^{are} not available for processing in P-Spec 2.2. However, Table 5.8 clearly states that the computations for the current values of GP_ATTITUDE and GP_VELOCITY depend upon the value of GP_ROTATION. In order to avoid this discrepancy in the specification, the computations of GP_ATTITUDE and GP_VELOCITY have been revised to refer to the data element G_ROTATION rather than GP_ROTATION.
- 4) When assigning values to the elements of GP_ROTATION, the design inadvertently referred to the first history of G_ROTATION when zero is the correct history of G_ROTATION. The design has been modified to refer to the zero history of G_ROTATION when assigning values to the elements of GP_ROTATION.
- 5) There are two instances where a check for a negative value has been added before performing a square root operation. It is not clear in either case why the absence of the check is a deficiency of the design.
- 6) There are three instances in which the extra output from a divide by zero exception message have been removed from the output.
- 7) a), and b) In reference to the phrase "if ((CONTOUR_ALTITUDE == 0) .or. (index == 100) then" the correct phrase is "if (CONTOUR_ALTITUDE(i) == 0) .or. i == 100)." The design has been modified to include the correct phrase.
- 8) The signal END_GCS has been removed from the design. The data element GP_PHASE is now used as a signal for controlling the overall activation of the processing comprising GCS. DFD 0, DFD 2, PAT 0-s1 and

7. Was the action related to another action(s)?

Yes ☒ No ☒ Do not know ☐

AR#(s) #17

Action Report Continuation

page 2 of 2

a. Report #:

18.1

b. Notes/Explanation (Please reference appropriate section number):

P-Spec 2.2 have all been modified to incorporate this change. The data element END_GCS has been removed from the data dictionary.

GCS Problem Report

page 1 of 1

1. PR #: 19	2. Planet: Pluto	3. Discovery Date: August 11, 1994	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design	X									
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

- 1) The Design Introduction has format and inconsistencies which hinder readability and comprehension.
- 2) The Design Description contains inconsistent notations and duplicate information.

7. Artifact Identification:

<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:
<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	Pluto Design Introduction
<input type="checkbox"/> Executable Object Code		Pluto Design Description

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
8/11/94		Angellatta		19.1
	8/24/94	Quach		
8/24/94	8/26/94	Hayhurst		
		()		

10. Total # of Changes: 16

11. Total # of No Changes: 0

12. Initiator Signature & Date

13. SOA Signature & Date

Original Signed by
Patrick Quach

8-24-94

Original Signed by
Kelly Hayhurst

8/26/94

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

GCS Action Report

page 1 of 2

1. AR#: 19.1	2. Planet: Pluto	3. Date of Action: Aug 11, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
5. Artifact Identification:		Configuration Item:	
<input checked="" type="checkbox"/> Design Description <input type="checkbox"/> Source Code <input type="checkbox"/> Executable Object Code		<input type="checkbox"/> Support Documentation <input type="checkbox"/> Other Pluto Design Introduction Pluto Design Description	
6. Description of Action			
<p>1) Modifications to the Design Introduction.</p> <p>The Design introduction has been entirely rewritten to comply with the design documentation standards as specified in the <i>Software Development Standards</i>.</p> <p>2) Modifications to the Teamwork Model.</p> <p>A) The name of the implementation has been changed from "GCS" to "PLUTO." This change affected the name of process 0 in the context diagram and DFD 0, and the name of PAT 0-s1 was affected as well.</p> <p>B) The body of P-Specs 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 2.2, 3.2, 3.3, and 3.4 have all been modified to reflect the algorithm description syntax as described in the Design Introduction. For the most part these changes involved altering the comment delimiters (from "/* */" to "(* *)"), altering the assignment operator (from "=" to "!="), altering the logical operators (from "==" to "=", from ".AND." to "AND", from ".OR." to "OR", and from ".NOT." to NOT), and altering the array notation (from "()" to "[]").</p> <p>C) Notes on the derivation of the algorithms were removed from the body of P-Specs 1.2 and 1.7 and inserted into the Design Introduction along with the algorithm notes of the other P-Specs.</p> <p>3) While reviewing the Pluto design for the changes made against this problem report, the verification analyst discovered that the formula specifying the "upper parabolic region" in P-Spec 1.7 TSP is incorrect. P-Spec 1.7 and the design introduction have been updated to reflect the proper equation. The correct equation is:</p> <p>upper-parabolic-equation =</p> $(x - (M4 - (((T4 - T3) / (M4 - M3)) / 2)))^2 + (T4 - (((T4 - T3) / (M4 - M3)) / 2)^2)$ <p>4) While reviewing the Pluto design for the changes made against this problem report, the verification analyst discovered that in P-Spec 2.2 GP, the error message reporting the data elements GP_ALTITUDE[0] and GP_VELOCITY[1, 0] "out of range" are incorrect. The incorrect error message listing the GP process as "ASP." This problem has been corrected by identifying the GP process as "GP."</p>			
7. Was the action related to another action(s)?		Yes AR#(s) <input checked="" type="checkbox"/> No Do not know	

Action Report Continuation

page 2 of 2

a. Report #:

19.1

b. Notes/Explanation (Please reference appropriate section number):

- 5) While reviewing the Pluto design for the changes made against this problem report, the verification analyst discovered that in P-Spec 2.2 GP, a range check was not performed on the data element VELOCITY_ERROR as required. A range check was added as necessary to P-Spec 2.2 GP for the data element VELOCITY_ERROR.

GCS Problem Report

page 1 of 1

1. PR #: 20	2. Planet: Pluto	3. Discovery Date: September 15, 1994	4. Initiator & Role: Designer/Angellatta
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design	<input checked="" type="checkbox"/>									
Code										<input checked="" type="checkbox"/>
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

spec
mod

6. Description of Problem:

The following updates are needed in the Pluto design to maintain compliance with the GCS Specification as updated by Formal Modification #2.3-4.

- 1) The base type of the data element "AE_TEMP" has been changed to Integer instead of Logical.
- 2) The data element "CHUTE_RELEASED" has been reassign to the EXTERNAL data store and removed from the GUIDANCE_STATE data store.

7. Artifact Identification:

☒ Design Description
☐ Source Code
☐ Executable Object Code

☐ Support Documentation
☐ Other

Configuration Item:
Pluto Design Description

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
9/16/94	9/16/94	Angellatta		20.1
9/16/94	9/16/94	Quach		
9/16/94	9/16/94	Hayhurst		

10. Total # of Changes: _____

11. Total # of No Changes: _____

12. Initiator Signature & Date

Original Signed by
 Rob Angellatta

Sep 16, 1994

13. SOA Signature & Date

Original Signed by
 Kelly Hayhurst

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

GCS Action Report

page 1 of 2

1. AR#: 20.1	2. Planet: Pluto	3. Date of Action: Sep. 16, 1994	4. Respondent & Role: Angellatta, R.K. Programmer
5. Artifact Identification: X Design Description Source Code Executable Object Code		Configuration Item: Support Documentation Other Pluto Design Description	
6. Description of Action			
<p>Formal Modification 2.3-4.1 No modifications to the Pluto design are necessary.</p> <p>Formal Modification 2.3-4.2 No modifications to the Pluto design are necessary.</p> <p>Formal Modification 2.3-4.3 ✓ a) The DDE AE_TEMP has been modified, the "data type" field has been changed from "Logical-1" to "Integer-2". b) P-Spec 1.8 CP has been modified as follows. The data type Integer-2 is two bytes in size, one byte larger than the data type Logical-1. This difference in the size of the data type for AE_TEMP makes it necessary to increase the length of the data packet for the third subframe. The data type of field AE_TEMP in the record structure "clp_data_t," which represents the data packet for the third subframe, has been changed from "byte" to "word". The comments regarding the length of the data packet have been changed from "44 bytes" to "45 bytes". The "length" argument of the call to function CRC16 for the third subframe has been changed from "44" to "45".</p> <p>Formal Modification 2.3-4.4 <i>it has been</i> The data element CHUTE_RELEASED has been removed from the DDE GUID-ANCE_STATE and the data flows named CP_GS_IN, GP_GS_IN, and AE-CLP_GS_IN. In DFD 2, the input data flow labeled FRAME_COUNTER connecting the data store EXTERNAL to bubble 3.2 has been renamed GP_EX_IN. GP_EX_IN contains the data elements CHUTE_RELEASED and FRAME_COUNTER. In DFD 3, the input data flow labeled FRAME_COUNTER connecting the data store EXTERNAL to bubble 3.2 has been renamed AE-CLP_IN. AECLP_EX_IN contains the data elements CHUTE_RELEASED and FRAME_COUNTER. Also, the data element CHUTE_RELEASED was removed from the data flow named CRCP_GS_IN. This action reduced the data flow to a single data element so the label CRCP_GS_IN was removed from the data flow and replaced with the single element name AE_TEMP. The input data flow labeled CHUTE_RELEASED connecting the data store to bubble 3.3 was removed and an input data flow labeled CHUTE_RELEASED connecting data store EXTERNAL to bubble 3.3 was created. Similarly, the output data flow labeled CHUTE_RELEASED connecting bubble 3.3 with data</p>			
7. Was the action related to another action(s)?			
Yes AR#(s) ✓ No Do not know			

Action Report Continuation

page 2 of 2

a. Report #:

20.1

b. Notes/Explanation (Please reference appropriate section number):

store GUIDANCE state was removed and an output flow labeled CHUTE_RELEASED connecting bubble 3.3 with data store EXTERNAL was created.

Formal Modification 2.3-4.5

No modifications to the Pluto design are necessary.

GCS Problem Report

page 1 of 2

1. PR #: 21	2. Planet: Pluto	3. Discovery Date: Nov. 16, 1994	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Code	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Unit Testing	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Functional	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Structural	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Subframe Testing	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Frame Testing	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Top-Level Simulator	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Integration Testing	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

6. Description of Problem:

The following are inaccuracies/deficiencies in the data flow diagrams, data dictionary, and design introduction.

- 1) GCS DFD-0 does not balance.
- 2) GCS PAT 0-S1
 - a) The comment above the table indicating what GP_PHASE is initialized to is inaccurate.
 - b) The table is missing the label for activation sequence where GP_PHASE <> "5"

GCS Data Dictionary Inaccuracies/deficiencies

- 3) The element CHUTE_RELEASED has an incorrect entry in its DATA STORE field.
- 4) The following data elements in the data dictionary have "data condition" entered in their ATTRIBUTE field but are used only as "data" flows.

AE_SWITCH	AE_TEMP
CONTOUR_CROSSED	RE_SWITCH
TD_SENSED	TDLR_STATE

7. Artifact Identification:

<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:
<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	Pluto Design Description
<input type="checkbox"/> Executable Object Code		

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
11/17/94	11/22/94	Morris		21
11/22/94	11/22/94	Quach		

10. Total # of Changes: 10

11. Total # of No Changes: 0

12. Initiator Signature & Date

13. SOA Signature & Date

Original Signed by
Patrick Quach

11-22-94

Original Signed by
Kelly Hayhurst

11/22/94

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 2

a. Report #: 21

b. Notes/Explanation (Please reference appropriate section number):

- 5) The element COMM_SYNC_PATTERN has a typo in its RANGE field

Design Introduction Inaccuracies/deficiencies

- 6) It would be helpful if the pages are numbered in the introduction.
- 7) The paragraph in section 2.2 justifying deficiencies in DFD should be removed. It is no longer needed if DFD-0 is to be changed so that it balances.
- 8) Typo in section 1.3
"...previous chosen to signify..."
- 9) Typo in section 2.3
"... oincide ..."
- 10) Typo in section 2.3. In the description for AECLIP, TE_LIMIT calculation, symbol for acceleration (X double dot) has inconsistent case. Its capitalized in the first 2 instances and lower case in the last instance.

GCS Action Report

page 1 of 1

1. AR #: 21.1	2. Planet: Pluto	3. Date of Action: Nov. 22, 1994	4. Respondent & Role: Reader/Morris
5. Artifact Identification: <div style="display: flex; justify-content: space-between;"> <div style="width: 30%;"> <input checked="" type="checkbox"/> Design Description <input type="checkbox"/> Source Code <input type="checkbox"/> Executable Object Code </div> <div style="width: 30%;"> <input checked="" type="checkbox"/> Support Documentation <input type="checkbox"/> Other </div> <div style="width: 35%;"> Configuration Item: </div> </div>			
6. Description of Action <p>The following actions were taken to correct inaccuracies/deficiencies in the data flow diagrams, data dictionary, and design introduction pertaining to problem report #21.</p> <ol style="list-style-type: none"> ✓1) GCS DFD-0 Data flows and Stores were added to GCS DFD-0 to make it balance. ✓2) GCS PAT 0-S1 <ol style="list-style-type: none"> a) The comment above the table was removed. b) The label "Other" was added to the table for cases when GP_PHASE <> "5" 3) The element CHUTE_RELEASED entry in its DATA STORE field was changed to EXTERNAL. 4) The following data elements in the data dictionary were corrected to have "data" in their ATTRIBUTE field: <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: left;"> AE_SWITCHED CONTOUR_CROSSED TD_SENSED </div> <div style="text-align: left;"> AE_TEMP RE_SWITCH TDLR_STATE </div> </div> 5) The element COMM_SYNC_PATTERN entry in its RANGE field was changed to hexadecimal (the more common spelling). 6) The Design Introduction's page numbers were raised to the printable region of the paper. 7) Two paragraphs were removed in section 2.2 since DFD-0 now balances. 8) The typo in section 1.3 "...previous chosen..." was changed to "...previously chosen..." 9) The typo "...oincide..." could not be found in section 2.3. 10) In the description of AECLP, TE_LIMIT calculation in section 2.3 one instance of (X double dot) was altered from normal to symbol to give it consistent text weight. 			
7. Was the action related to another action(s)? <div style="display: flex; justify-content: flex-end; margin-top: 5px;"> <input type="checkbox"/> Yes AR#(s) <input checked="" type="checkbox"/> No <input type="checkbox"/> I don't know </div>			

GCS Problem Report

page 1 of 3

1. PR #: 22	2. Planet: Pluto	3. Discovery Date: Nov. 16, 1994	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design										
Code		X								
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The following are inaccuracies/deficiencies in the functional unit P-Specs in the PLUTO design.

- 1) The following P-Specs contain "return" as the P-Spec terminator. This may cause confusion among readers and should be removed:
 - CRCP
 - AECLP
 - ASP
 - ARSP
 - GSP
 - RECLP
 - TDLRSP
 - TDSP
 - TSP
 - GP

7. Artifact Identification:

<input checked="" type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:
<input type="checkbox"/> Source Code	<input type="checkbox"/> Other	Pluto Design Description
<input type="checkbox"/> Executable Object Code		

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
11/29/94	11/29/94	Morris		22.1
11/29/94	11/29/94	Quach		

10. Total # of Changes: 14

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by
Patrick Quach

13. SOA Signature & Date

Original Signed by
Kelly Hayhurst

11/29/94

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 3

a. Report #: 22

b. Notes/Explanation (Please reference appropriate section number):

Inaccuracies/deficiencies specific to ASP

- 2) It has been determined in the code review that the equation for computing the standard deviation found in the most recent version of the Specification should be used. As a consequence, the comment on page 4 near the bottom addressing the digital representation of real numbers can be removed.
- 3) Also as a consequence, the description for computing the standard deviation should be updated.

Inaccuracies/deficiencies specific to CP

- 4) At the bottom of page 5 where subframe_t is defined:
"type subframe_t = (subframe_t, gp_data_t, clp_data_t)"
The "subframe_t", on the right hand side of the assignment, is incorrect.
- 5) At the top of page 8, in each of the assignment statements for GP_ROTATION and GP_VELOCITY, there is no subscript on the left hand side.
- 6) At the bottom of page 9, where the looping starts for computing the CRC, the statement:
"do for each byte in the message next_byte", does not specify which index to start with.
i.e. 1 to 255 or vice versa.
- 7) In the middle of page 7, the assignment statements for the following variables use the wrong closing index marker:
 TDLR_STATUS[2]
 TDLR_STATUS[3]
 TS_STATUS[2]
- 8) Typo on page 2: In comments, "consist of" should be "consists of"
- 9) Typo on page 3: Comment which gives total no of bytes for sensor processing, "127" should be "129"
- 10) Typo on page 4: In comments, "returns and integer" should be "returns an integer"

Inaccuracies/deficiencies specific to GP

- 11) Typo on page 9:
"Exapolation" should be "Extrapolation" in two places
"Exapolate" should be "Extrapolate"
- 12) Typo on page 10: "range check the current altitude" should be "range check the VELOCITY_ERROR"

Problem Report Continuation

page 3 of 3

a. Report #: 22

b. Notes/Explanation (Please reference appropriate section number):

- 13) Typo on page 11
"GP_ALTITUDE[0] =<" should be "GP_ALTITUDE[0] <=" for consistency
- 14) On the top of Page 6: In each of the equations for att_k2, vel_k2, alt_k2, att_k3, vel_k3, and alt_k3, the right parenthesis preceding the term "/2" is not in the correct place., and thus the attitude, velocity, and altitude arguments for the derivative routines are not correct.
- 15) An unnecessary range check for altitude follows the "END P_SPEC" marker.
- 16) In the description for computing the vehicle velocity, the description for pv, qv, rv are in the middle of the velocity derivative computation. This is potential confusing.

Inaccuracies/deficiencies specific to TDLRSP

- 17) Typo on the bottom of page 7, the statement:
"where cos represents the cosine function"
appears to be a comment but has not been delineated as such.

Inaccuracies/deficiencies specific to ARSP

- 18) Typo at the bottom of page 2: "recieved" should be "received"

Inaccuracies/deficiencies specific to TDSP

- 19) Typo in page 1: "hexidecimal" should be "hexadecimal"

GCS Action Report

page 1 of 2

1. AR #: 22.	2. Planet: Pluto	3. Date of Action: Nov. 29, 1994	4. Respondent & Role: Reader/Morris
5. Artifact Identification: <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div> <input checked="" type="checkbox"/> Design Description <input type="checkbox"/> Source Code <input type="checkbox"/> Executable Object Code </div> <div> <input checked="" type="checkbox"/> Support Documentation <input type="checkbox"/> Other </div> <div>Configuration Item:</div> </div>			
6. Description of Action The following actions were taken to correct inaccuracies and deficiencies in the P-Specs pertaining to problem report #22. <ol style="list-style-type: none"> 1) In the following P-Specs "return" was removed: <div style="display: flex; justify-content: space-around; margin-top: 5px;"> <div>CRCP ARSP TDLRSP GP</div> <div>AECLP GSP TDSP</div> <div>ASP RECLP TSP</div> </div> 2) In P-Spec ASP, the comment before computing the standard deviation addressing digital representation of real numbers was removed. 3) In P-Spec ASP, The description for computing the standard deviation was updated to match the spec. EXTRA In P-Spec ASP, the comment and description for checking for negative values following the computation for the standard deviation was removed since it was no longer needed. 4) In P-Spec CP, the assignment "subframe_t" on page 5 was altered to "sp_data_t". 5) In P-Spec CP, subscripts were added to each assignment statement for GP_ROTATION and GP_VELOCITY on page 8. 6) In P-Spec CP, "do for each byte in the message next_byte" on page 9 was altered to read, "do next_byte := 1 to bytecount" to remove confusion on the value of next_byte. 7) In P-Spec CP, the index markers were changed from ")" to "]" for TDLR_STATUS and TS_STATUS. 8) In P-Spec CP, in the comments on page 2 "consist of" was change to "consists of". 9) In P-Spec CP, in the comments on page 3 total number of bytes was altered from "127" to "129". 10) In P-Spec CP, in the comments on page 4 "returns and integer" was changed to "returns an integer". 11) In P-Spec GP, in various comments on page 9, "Exapolation" and "Exapolate" were changed to "Extrapolation" and "Extrapolate" respectively. 12) In P-Spec GP, in the comments on page 10 "range check the current altitude" was changes to read, "range check the VELOCITY_ERROR" 13) In P-Spec GP, on page 11 "GP_ALTITUDE[0] =<" was change to "GP_ALTITIDE <=" 			
7. Was the action related to another action(s)? <div style="display: flex; justify-content: flex-end; margin-top: 5px;"> <input type="checkbox"/> Yes AR#(s) <input checked="" type="checkbox"/> No <input type="checkbox"/> I don't know </div>			

GCS Action Report Continuation

page 2 of 2

1. AR #: 22. (2. Planet: Pluto	3. Date of Action: Nov. 29, 1994	4. Respondent & Role: Reader/Morris
6. Description of Action			
<p>14) In P-Spec GP, on page 6 the closing parenthesis for the equations for att_k2, vel_k2, alt_k2, att_k3, vel_k3, alt_k3 was moved to precede the term "/2".</p> <p>15) In P-Spec GP, the range check for altitude following "End P_SPEC" was removed.</p> <p>16) In P-Spec GP, the description for pv, qv, and rv was moved into the comments above the description for computing vehicle velocity.</p> <p>17) In P-Spec TDLRSP, on page 7 "where cos represents the cosine function" was delineated as a comment.</p> <p>18) In P-Spec ARSP, in the comments on page 2, "recieved" was changed to "received".</p> <p>19) In P-Spec TDSP, in the comments on page 1, "hexidecimal" was changed to "hexadecimal".</p>			
<p>7. Was the action related to another action(s)?</p> <p> <input type="checkbox"/> Yes AR#(s) <input checked="" type="checkbox"/> No <input type="checkbox"/> I don't know </p>			

GCS Problem Report

page 1 of 4

1. PR #: 23	2. Planet: Pluto	3. Discovery Date: Nov. 16, 1994	4. Initiator & Role: Inspector/Quach and Becher
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	ICE	R	O
Design										
Code		X								
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The following are inaccuracies/deficiencies in the Pluto source code.

- For traceability and document accounting purposes, it would be useful to indicate the P-Spec. identification in the source code files which map to a design artifact.

- Constants used in the code, in the following cases, should have the appropriate precision as required for the particular usage:

Subroutine Name	Lines	Constant
✓ AECLP.FOR	978	"0.5"
ASP.FOR	818, 837	"3.0"
ARSP.FOR	746	"3E08"
GP.FOR	995,1007,1017	"6.0"
	993,1006,1017	"2.0"
	1086	"1000.0"
TDLRSP.FOR	925,935,948,959...	"2.0"
✓ TSP.FOR	738,749	"0.15"
LOWER_PARABOLIC_FUNCTION	178	"2.0"
UPPER_PARABOLIC_FUNCTION	178	"2.0"

7. Artifact Identification:

<input type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:
<input checked="" type="checkbox"/> Source Code	<input type="checkbox"/> Other	Pluto Code
<input type="checkbox"/> Executable Object Code		

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
11/27/94	12/1/94	Morris		23.1
12/1/94	12/5/94	Quach		
12/5/94	12/5/94	Hayhurst	Code was considered too voluminous to attach to AR	

10. Total # of Changes: 33

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by
Patrick Quach

12-5-94

13. SOA Signature & Date

Original Signed by
Kelly Hayhurst

12/5/94

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 4

a. Report #: 23

b. Notes/Explanation (Please reference appropriate section number):

- 3) CONSTANT.FOR: The upper and lower bounds of all real constants need to be appropriately entered.
- 4) CONSTANT.FOR: The constants for AE_TEMP have incorrect types. They should be INTEGER*2
- 5) EXTERNAL.FOR: Under "structure /clp_data_1/", the data type for ae_temp is incorrect.
- 6) PLUTO.FOR: The third subframe is not executed when GP_PHASE = 5. According to the Specification, the third subframe should be executed before exiting the loop.
- 7) PLUTO.FOR: A GOTO statement is used to exit the loop, this should be avoided if possible.
- 8) AECLP.FOR: A divide-by-zero check is required for the variable OMEGA. at line 895-897
- 9) CP.FOR: In line 37 of the CRC16 subroutine, the hexadecimal constant given for the CRC-16 generator polynomial is not correct. It has an extra "1" before the "A".
- 10) CP.FOR: In the CRC16 subroutine, the section "Returns..." in the subroutine header states that CRC16 is "the CRC-16" of the specified message." The "CRC-16 is a bit ambiguous, as it does not explicitly state it is the checksum or error code.
- 11) CP.FOR: The assignment of the sequence field directly from the MOD intrinsic function is erroneous. The MOD function returns a integer quantity but its assigned to a logical.
- 12) ARSP.FOR: There is a typo in the comment for step 3C)
"...mostly recently..."
- 13) GP.FOR: In line 909, the first argument , namely "att_k1", is incorrect.
- 14) GP.FOR: In lines 921 & 922, 925 & 926, 929, 939 & 940, 943 & 944, and 947 the subroutines avg_att and avg_vel are performing an incorrect function, and thus the second argument for each derivative call is incorrect.
- 15) GP.FOR: In line 970, the last argument for deriv_vel, namely "1", is not correct.
- 16) GP.FOR: Lines 1095, 1114, 1132, 1156, 1203, 1224, and 1256 use unconditional GOTO statements deviating from the design
- 17) GP.FOR: In line 1178, the relational operator, namely ".GE.", is a typo. Should be .LE. according to the design
- 18) GP.FOR: In the DERIV_ATT subroutine lines 72-74, it was intended that the variables pv, qv, and rv will yield the appropriate values of Q_ROTATION. The EQUIVALENCE statements do not accomplish what was intended because Fortran arrays are column major, and therefore, lines 78 through 88 will yield incorrect results.

Problem Report Continuation

page 3 of 4

a. Report #: 23

b. Notes/Explanation (Please reference appropriate section number):

- 19) GP.FOR: In the DERIV_VEL subroutine lines 297-299, it was intended that the variables pv, qv, and rv will yield the appropriate values of Q_ROTATION. The EQUIVALENCE statements do not accomplish what was intended, and therefore, lines 309, 316, AND 323 will yield incorrect results.
- 20) GP.FOR: In the DERIV_VEL subroutine, the index for "temp(1)" is incorrect for the following statements:
temp(1) = TDLR_VELOCITY(2,index) - vel(2)
temp(1) = TDLR_VELOCITY(3,index) - vel(3)
- 21) GP.FOR: The subroutines AVG_ATT and AVG_VEL are performing an unnecessary function.
- 22) GP.FOR: In the MULT_ATT subroutine, the second index, of the array element to be multiplied with the "factor", is incorrect for the following elements
att(1,2)
att(1,3)
att(2,2)
att(2,3)
att(3,2)
att(3,3)
- 23) GSP.FOR: The local variable "counter" is typed as a "real*8" when it should be an "integer*2"
- 24) TDLRSP.FOR: In lines 906-909 the computed GOTO statement has no default case to handle cases where the computed expression is other than 1 to 15
- 25) TDLRSP.FOR: The branch between lines 957-963 is missing a control statement and will incorrectly fall through.
- 26) TSP.FOR: There is an inconsistency at line 718 in argument types being passed into the ZERO_CHECK subroutine. The first argument being passed in, "M2-M1" is an integer begin passed into a real argument.
- 27) TSP.FOR: In the LOWER_PARABOLIC_FUCNTION. In line 181, the addition operator in the term "...M3 + half_slope..." is incorrect.
- 28) TSP.FOR: In the UPPER_PARABOLIC_FUCNTION. In line 181, both arithmetic operators immediately preceding "half_slope" (namely "-" and then "+") are incorrect.
- 29) UTILITY.FOR: In the subroutines RANGE_CHECK, NEO_VALUE_CHECK, and ZERO_CHECK. the FORMAT statement 30 is missing "x," immediately before the "14".
- 30) EXTERNAL.FOR: Heading: "Originial" should be "Original"

Problem Report Continuation

page 4 of 4

a. Report #: 23

b. Notes/Explanation (Please reference appropriate section number):

- 31) ~~ASP.FOR~~ ^{ASP.FOR} page 6, comment on line 970:
"conversion" should be "conversion"
- 32) GP.FOR: page 9, lines 1125, 1141, and 1149:
"exapolat..." should be "extrapolat..."
- 33) GP.FOR: For the computed GOTO statement at line 1190, the default processing just falls through.
This is not robust.

GCS Action Report

page 1 of 2

1. AR #: 23, 1	2. Planet: Pluto	3. Date of Action: Dec. 1, 1994	4. Respondent & Role: Reader/Morris
5. Artifact Identification: <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div> <input checked="" type="checkbox"/> Design Description <input checked="" type="checkbox"/> Source Code <input type="checkbox"/> Executable Object Code </div> <div> <input checked="" type="checkbox"/> Support Documentation <input type="checkbox"/> Other </div> <div>Configuration Item:</div> </div>			
6. Description of Action <p>The following actions were taken to correct inaccuracies/deficiencies in the Pluto code pertaining to problem report #23.</p> <ol style="list-style-type: none"> 1) The appropriate P-Spec identification was added to all source code files. 2) Most constants used in the code are as precise as required. Excerpt from VAX Fortran Volume 2, pg. 2-45 "The data type of the value produced by an operation on two arithmetic elements of different types is the data type of the highest-ranked element in the operation." However, two constants were altered, AECLP.FOR "0.5" to "0.5D0" and TSP.FOR "0.15" to "0.15D0", to insure the value would not change from casting. 3) In CONSTANT.FOR a "D0" was added to the end of real constants that did not end in a "0", to insure the value would not change if casted. 4) In CONSTANT.FOR the types for AE_TEMP were changed to INTEGER*2. 5) In EXTERNAL.FOR the data type of ae_temp was altered to integer*2. 6&7) In PLUTO.FOR a DO WHILE loop was implemented to remove the unconditional GOTOs and insure all subframes were executed. 8) In AECLP.FOR a check for zero was added to avoid a divide-by-zero. 9) In CP.FOR the extra "I" was removed from the comment on line 37. 10) In CP.FOR the comment for CRC16 the description of crc16 was changed to state it was a bit checksum. 11) In CP.FOR, Added a temp variable and equivalence command to properly cast the byte. 12) In ARSP.FOR the comment for step 3C was altered to read "...most recently..." 13) In GP.FOR the first argument on line 909 was altered to "vel_k1" 14) In GP.FOR the averaging subroutines were changed to perform the correctly divide the last parameter by 2 instead of averaging. 15) In GP.FOR the last argument for deriv_vel on line 970 was changed to "0". 			
7. Was the action related to another action(s)? <div style="display: flex; justify-content: flex-end; margin-top: 5px;"> <div style="margin-right: 20px;"> <input type="checkbox"/> Yes AR#(s) </div> <div> <input checked="" type="checkbox"/> No </div> <div> <input type="checkbox"/> I don't know </div> </div>			

GCS Action Report Continuation

page 2 of 2

AR #: 23.1	2. Planet: Pluto	3. Date of Action: Dec. 1, 1994	4. Respondent & Role: Reader/Morris
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6. Description of Action

16) In GP.FOR on lines 1095, 1114, 1132, 1156, 1203, 1224, and 1256 use an unconditional GOTO. The design states using a do loop and breaking the loop by changing the incrementing variable. This is not allowed in Fortran, but is allowed in other languages. The unconditional GOTOs serve the best translation of the design in Fortran.

17) In GP.FOR on line 1178, the relational operator was changed to .LE.

18) In GP.FOR in the DERIV_ATT subroutine, the references to pv, qv, and rv were replaced with their equivalent G_ROTATION variable.

19) In GP.FOR in the DERIV_VEL subroutine, the references to pv, qv, and rv were replaced with their equivalent G_ROTATION variable.

20) In GP.FOR in the DERIV_VEL subroutine, the indexes to temp were properly incremented.

21) In GP.FOR the averaging subroutines were changed to perform the correctly divide the last parameter by 2 instead of averaging.

22) In GP.FOR in the MULT_VEL subroutine, the indexes to att were properly incremented.

23) In GSP.FOR the variable "counter" was typed to "integer*2"

24) In TDLRSP.FOR in lines 906-909 was given a default case of 2000.

25) In TDLRSP.FOR in lines 957-963 was given a control statement.

26) In TSP.FOR at line 718 an extra variable was added to cast M1-M2 to a real before using it as an argument for ZERO_CHECK.

27) In TSP.FOR in the LOWER_PARABOLIC FUNCTION the equation was matched to the design.

28) In TSP.FOR in the UPPER_PARABOLIC FUNCTION the equation was matched to the design.

29) In UTILITY.FOR, an "x" was applied before the "I4" in the format statements to the subroutines RANGE_CHECK, NEG_VALUE_CHECK, and ZERO_CHECK.

30) In all source code files in the heading "Original" was altered to "Original"

31) ASP.FOR has no line 970 or page 6, so there was nothing to change.

32) In GP.FOR all incorrect forms of "extrapolate" were corrected.

33) In GP.FOR the computed GOTO statement at line 1190 was given a default.

7. Was the action related to another action(s)?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> I don't know	AR#(s)
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GCS Problem Report

page 1 of 2

1. PR #: 24	2. Planet: Pluto	3. Discovery Date: 12-28-94	4. Initiator & Role: Quach/Tester
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design										
Code										
Unit Testing										
Functional								X		
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

Testing on GP functional unit revealed the following:

- 1) In the Subroutine AVG_ATT, the wrong index were used to perform the calculation.
- 2) While computing the second estimate of the RK algorithm:
 - a) The last step of the velocity estimate multiplies the wrong variable with the step-size
 - b) While calculating the derivative for altitude, the attitude(2) is averaged into the previous estimate instead of adding 50% of the previous estimate.
- 3) While computing the third estimate of the RK algorithm, the derivative for the altitude repeats the averaging error as #2b)
- 4) In computing the forth estimate of the RK, the velocity calculation multiplies the wrong variable with step-size

7. Artifact Identification:

<input type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:
<input checked="" type="checkbox"/> Source Code	<input type="checkbox"/> Other	PLUTO Source Code
<input type="checkbox"/> Executable Object Code		

8. Test Case Identification: GP_NR_001, TSP_NR_001-003, TSP_RO_004-005, TSP_NR_006-007, TSP_RO_008-011, RECLP_NR_001, TDRLSP_RO_026, ARSP_NR_017, ARSP_NR_022, ARSP_NR_023

9. History Log:

Date To	Date From	Person	Comments	AR#
1/10/95	1/10/95	Morris		24.1
1/10/95	1/11/95	Quach		
1/11/95	1/13/95	Hayhurst	Asked for greater detail on Action Report revisions xxx mdd	

10. Total # of Changes: 9

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by
Patrick Quach

1-11-95

13. SOA Signature & Date

Original Signed by
Kelly Hayhurst

1/13/95

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

Problem Report Continuation

page 2 of 2

a. Report #: 24

b. Notes/Explanation (Please reference appropriate section number):

Testing on RECLP functional unit revealed the following:

- 1) The lower and upper bounds for the variable THETA is listed backwards in the CONSTANT.FOR file thus causing erroneous printing of out of bounds messages.

Testing on TSP revealed the following:

- 1) The upper and lower parabolic functions are expecting real variables but are in some cases receiving integer parameters.

Testing on TDLRSP revealed the following:

- 1) The next TDLR state is incorrectly set for cases where the value current TDLR state is in the invalid equivalence class TDLR_STATE.3

Testing on ARSP revealed the following:

- 1) AR_ALTITUDE is not accurately calculated in cases where AR_COUNTER is used.

GCS Action Report

page 1 of 1

1. AR #: 24.1	2. Planet: Pluto	3. Date of Action: Jan. 10, 1995	4. Respondent & Role: Reader/Morris
5. Artifact Identification: <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div> <input type="checkbox"/> Design Description <input checked="" type="checkbox"/> Source Code <input type="checkbox"/> Executable Object Code </div> <div> <input type="checkbox"/> Support Documentation <input type="checkbox"/> Other </div> <div>Configuration Item:</div> </div>			
6. Description of Action <p>The following actions were taken to correct inaccuracies and deficiencies in the Pluto code pertaining to problem report #24.</p> <ol style="list-style-type: none"> 1) In GP.FOR in the subroutine AVG_ATT, all the index values for ATT_1 and ATT_2 were changed to correspond with the same indices as used for the variable RESULT. 2) In GP.FOR in the second estimate of the RK algorithm ATT_K2 was changed to VEL_K2 to multiply the step-size. Also changed the division placement for calculating the derivative for altitude. 3) In GP.FOR in the third estimate of the RK algorithm, the division by 2 for calculating the derivative for altitude was moved to inside the parenthesis so that the correct value is passed into the DERIV_ALT subroutine. 4) In GP.FOR, the fourth estimate of the RK algorithm calls the MULT_VEL subroutine with the wrong variable. The ATT_K4 was changed to VEL_K4 to multiply the step-size in the call to the MULT_VEL subroutine. 5) In CONSTANT.FOR, the lower and upper bounds for THETA were changed. The lower bound was changed from 3.14... to -3.14... The upper bound was changed from -3.14... to 3.14... 6) In TSP.FOR the variable, REAL_THERMO_TEMP was added and the calls to the lower and upper parabolic functions that previously passed integer variables were changed to pass the real variable declared. This insures a proper casting for the function. 7) In TDLRSP.FOR, the a qualifier was added to the else branch for determining TDLR_STATE and FRAME_BEAM_UNLOCKED. This more accurately implements row 3 of table 5.11 in the Spec. The "else" was replaced by: elseif (tdlr_state = beam_unlocked) 8) In ARSP.FOR the equation that calculates the altitude based on AR_COUNTER uses the constant "3E08". It was changed to "3D08" to more accurately calculate the AR_ALTITUDE. <p>Extra) In ARSP.FOR, 'ASP' was changed to 'ARSP' in all the calls to the RANGE_CHECK subroutine. This allows the correct functional unit name to be printed when displaying the upper and lower bounds limit exceeded messages.</p>			
7. Was the action related to another action(s)? <div style="display: flex; align-items: center; margin-left: 20px;"> <input checked="" type="checkbox"/> Yes AR#(s) 23 <input type="checkbox"/> No <input type="checkbox"/> I don't know </div>			

GCS Problem Report

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1. PR #: 25	2. Planet: Pluto	3. Discovery Date: 1-12-95	4. Initiator & Role: Quach/Tester
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design										
Code										
Unit Testing										
Functional								X		
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

Testing on CP functional unit revealed the following error:

The three calls to the CRC16 subroutine passes the portion of the record that contains only the subframe specific data. According to the Spec., the Synchronization Pattern and the Sequence Number should also be considered in the CRC generation.

7. Artifact Identification:

<input type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:
<input checked="" type="checkbox"/> Source Code	<input type="checkbox"/> Other	PLUTO Source Code: CP.FOR
<input type="checkbox"/> Executable Object Code		

8. Test Case Identification: CP_NR_001, CP_NR_002, CP_NR_003, CP_NR_004, CP_NR_005

9. History Log:

Date To	Date From	Person	Comments	AR#
1/13/95	1/13/95	Morris		25.1
1/13/95	1/13/95	Quach		
1/13/95	1/13/95	Hayhurst		

10. Total # of Changes: 2

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by
Patrick Quach

1-13-95

13. SOA Signature & Date

Original Signed by
Kelly Hayhurst

1/13/95

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

GCS Action Report

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1. AR #: 25,1	2. Planet: Pluto	3. Date of Action: Jan. 13, 1995	4. Respondent & Role: Reader/Morris
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5. Artifact Identification:

<input type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:
<input checked="" type="checkbox"/> Source Code	<input type="checkbox"/> Other	CP FOR
<input type="checkbox"/> Executable Object Code		

6. Description of Action

The following actions were taken to correct inaccuracies and deficiencies in the Pluto code pertaining to problem report #25.

1) In CP.FOR, the three calls to the CRC16 function have been changed so that the entire PACKET is sent to CRC generation function instead of just the .sp, .gp, or .clp portions. The following changes were made:

```

.... = CRC16 (PACKET.sp,K$SP_SIZE)  changed to ...= CRC16 (PACKET.PACKET,K$SP_SIZE)
.... = CRC16 (PACKET.gp,K$GP_SIZE)  changed to ...= CRC16 (PACKET.PACKET,K$GP_SIZE)
.... = CRC16 (PACKET.clp,K$CLP_SIZE) changed to ...= CRC16 (PACKET.PACKET,K$CLP_SIZE)
    
```

Extra) In the CRC16 function, entry #229 of the CRC16_TABLE has a typographical error. It should be "8BC1" instead of "88C1". This change is made to make the table agree with Table 6 of the report on which the PLUTO CRC algorithm is based. The report is:

"Byte-wise CRC Calculations", Aram Perez, IEEE Micro, June 1983 p.40.

7. Was the action related to another action(s)?

<input type="checkbox"/> Yes	AR#(s)
<input checked="" type="checkbox"/> No	
<input type="checkbox"/> I don't know	

GCS Problem Report

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1. PR #: 26	2. Planet: Pluto	3. Discovery Date: 2-13-95	4. Initiator & Role: Quach/Tester
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design										
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing								X		
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

In preparation for frame and subframe testing, the following errors were found in the PLUTO subframe and frame level routines:

- 1) In CLPSF.FOR: There is Typo which prevents the linker to complete. Namely the "CALL AELCP" should be "CALL AECLP"
- 2) In PLUTO.FOR: There us a line of dead code that should be commented out. The following is ineffectual: "100 Continue"

7. Artifact Identification:

☐ Design Description
☒ Source Code
☐ Executable Object Code

☐ Support Documentation
☐ Other

Configuration Item:
PLUTO Source Code: CLPSF.FOR & PLUTO.FOR

8. Test Case Identification: CLP_001-014, FRAME_001-009

9. History Log:

Date To	Date From	Person	Comments	AR#
2/13/95	2/15/95	Morris		26.1
2/15/95	2/15/95	Quach		
2/15/95	2/15/95	Hayhurst		

10. Total # of Changes: 2

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by
Patrick Quach

2-15-95

13. SOA Signature & Date

Original Signed by
Kelly Hayhurst

2/15/95

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

GCS Action Report

page 1 of 1

1. AR #: 26.1	2. Planet: Pluto	3. Date of Action: Jan. 13, 1995	4. Respondent & Role: Reader/Morris
5. Artifact Identification: <input type="checkbox"/> Design Description <input type="checkbox"/> Support Documentation Configuration Item: <input checked="" type="checkbox"/> Source Code <input type="checkbox"/> Other <input type="checkbox"/> Executable Object Code			
6. Description of Action The following actions were taken to correct inaccuracies and deficiencies in the Pluto code pertaining to problem report #26. 1) In CLPSF.FOR "CALL AELCP" was changed to "CALL AECLP". 2) In PLUTO.FOR the dead code "100 Continue" was removed.			
7. Was the action related to another action(s)? <input type="checkbox"/> Yes AR#(s) <input checked="" type="checkbox"/> No <input type="checkbox"/> I don't know			

GCS Problem Report

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1. PR #: 27	2. Planet: Pluto	3. Discovery Date: 3-10-95	4. Initiator & Role: Quach/Tester
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5. Activity at Discovery:

Development Phases	* Activity									
	DR	CR	RC	RS	TRR	TCR	TCC	TCE	R	O
Design										
Code										
Unit Testing										
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator								X		
Integration Testing										

6. Description of Problem:

In executing trajectory test cases, the following error was discovered in Pluto's ASP functional unit:

- 1) Minute floating point errors in the mean calculations can cause the A_STATUS to be set incorrectly for the case where the three elements to average are identical.

In reviewing Pluto's ASP functional unit, the following was discovered:

- 2) The standard deviation is not implemented exactly as indicated in the GCS Specification, although it is a correct calculation for standard deviation, it leaves open the possibility that the software will fail as a result of a negative square root.

Trajectory test cases indicate that table 5.9 and 5.10 have a potential negative square root calculation. Modification to the Spec. necessitates the following modification to the GP functional unit:

- 3) The Left-hand-side of the MAX-NORMAL-VELOCITY compare has been changed to include a MAX function. The Pluto code should be likewise updated.

7. Artifact Identification:

☐ Design Description
☒ Source Code
☐ Executable Object Code

☐ Support Documentation
☐ Other

Configuration Item:

PLUTO Source Code: ASP.FOR, GP.FOR

8. Test Case Identification: TRAJ_TD_019, TRAJ_TD_021

9. History Log:

Date To	Date From	Person	Comments	AR#
3/10/95		F Becher	These problems result from problems in the spec - resulting in spec mod SWP # 2.3-7	
3/15/95	3/16/95	Morris		27.1
3/16/95	3/18/95	Quach		

10. Total # of Changes: 5

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by
Patrick Quach

3-17-95

13. SOA Signature & Date

Original Signed by
Kelly Hayhurst

3/21/95

Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

GCS Action Report

page 1 of 1

1. AR #: 27.1	2. Planet: Pluto	3. Date of Action: Mar. 16, 1995	4. Respondent & Role: Programmer/Morris												
5. Artifact Identification: <table style="width: 100%; border: none;"> <tr> <td style="width: 30%;"><input checked="" type="checkbox"/> Design Description</td> <td style="width: 10%; text-align: center;">—</td> <td style="width: 30%;">Support Documentation</td> <td style="width: 30%;">Configuration Item:</td> </tr> <tr> <td><input checked="" type="checkbox"/> Source Code</td> <td style="text-align: center;">—</td> <td>Other</td> <td>ASP.FOR, GP.FOR</td> </tr> <tr> <td><input type="checkbox"/> Executable Object Code</td> <td></td> <td></td> <td>P-Spec 1.3, P-Spec 2.2</td> </tr> </table>				<input checked="" type="checkbox"/> Design Description	—	Support Documentation	Configuration Item:	<input checked="" type="checkbox"/> Source Code	—	Other	ASP.FOR, GP.FOR	<input type="checkbox"/> Executable Object Code			P-Spec 1.3, P-Spec 2.2
<input checked="" type="checkbox"/> Design Description	—	Support Documentation	Configuration Item:												
<input checked="" type="checkbox"/> Source Code	—	Other	ASP.FOR, GP.FOR												
<input type="checkbox"/> Executable Object Code			P-Spec 1.3, P-Spec 2.2												
6. Description of Action <p>The following actions were taken to correct inaccuracies and deficiencies in the Pluto code^{and design} pertaining to problem report #27.</p> <p>1) In ASP.FOR the determination of Λ_STATUS was altered to set Λ_STATUS correctly for cases when the three elements to average are identical. The Pluto design (P-Spec 1.3) was changed to indicate that the mean and standard deviation is calculated only if all Λ_STATUS values are healthy and all three previous $\Lambda_ACCELERATIONS$ are not identical. This reflects the change in the Spec. Mod. 2.3-7.</p> <p>2) In ASP.FOR the standard deviation calculation was changed to a mathematical equivalent to remove the possibility of taking the square root of a negative number.</p> <p>3) In GP.FOR a MAX function was added to the left hand side of both instances of comparison with MAX-NORMAL-VELOCITY. The Pluto design (P-Spec 2.2) was changed to reflect the change in the Spec. Mod. 2.3-7.</p>															
7. Was the action related to another action(s)? <table style="margin-left: 20px; border: none;"> <tr> <td><input type="checkbox"/> Yes</td> <td>AR#(s)</td> </tr> <tr> <td><input checked="" type="checkbox"/> No</td> <td></td> </tr> <tr> <td><input type="checkbox"/> I don't know</td> <td></td> </tr> </table>				<input type="checkbox"/> Yes	AR#(s)	<input checked="" type="checkbox"/> No		<input type="checkbox"/> I don't know							
<input type="checkbox"/> Yes	AR#(s)														
<input checked="" type="checkbox"/> No															
<input type="checkbox"/> I don't know															

GCS Problem Report

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1. PR #: 28	2. Planet: Pluto	3. Discovery Date: 4-6-95	4. Initiator & Role: Quach/Tester
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5. Activity at Discovery:

Development Phases	DR	CR	RC	RS	* Activity TRR	TCR	TCC	TCE	R	O
Design										
Code										
Unit Testing								X		
Functional										
Structural										
Subframe Testing										
Frame Testing										
Top-Level Simulator										
Integration Testing										

6. Description of Problem:

The Pluto source code files do not have the proper end of line characters. This resulted in syntax errors during compilation using the VAX FORTRAN compiler.

7. Artifact Identification:

☐ Design Description
☒ Source Code
☐ Executable Object Code

☐ Support Documentation
☐ Other

Configuration Item:
PLUTO Source Code: all files

8. Test Case Identification:

9. History Log:

Date To	Date From	Person	Comments	AR#
4/6/95	4/6/95	Quach		281
4/6/95	4/6/95	Hayhurst		

10. Total # of Changes: 1

11. Total # of No Changes: 0

12. Initiator Signature & Date

Original Signed by
Patrick Quach

4-6-95

13. SQA Signature & Date

Original Signed by
Kelly Hayhurst

4/6/95

* Activity: DR - Design Review; CR - Code Review; RC - Reading Code; RS - Reading Specification; TRR - Test Readiness Review; TCR - Test Completion Review; TCC - Test Case Creation; TCE - Test Case Execution; R - Regression; O - Other.

GCS Action Report

page 1 of 1

1. AR #: 28.1	2. Planet: Pluto	3. Date of Action: Apr. 6, 1995	4. Respondent & Role: Tester/Quach									
5. Artifact Identification: <table style="width: 100%; border: none;"> <tr> <td style="width: 33%;"><input type="checkbox"/> Design Description</td> <td style="width: 33%;"><input type="checkbox"/> Support Documentation</td> <td style="width: 34%;">Configuration Item:</td> </tr> <tr> <td><input checked="" type="checkbox"/> Source Code</td> <td><input type="checkbox"/> Other</td> <td>All pluto source code files</td> </tr> <tr> <td><input type="checkbox"/> Executable Object Code</td> <td></td> <td></td> </tr> </table>				<input type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:	<input checked="" type="checkbox"/> Source Code	<input type="checkbox"/> Other	All pluto source code files	<input type="checkbox"/> Executable Object Code		
<input type="checkbox"/> Design Description	<input type="checkbox"/> Support Documentation	Configuration Item:										
<input checked="" type="checkbox"/> Source Code	<input type="checkbox"/> Other	All pluto source code files										
<input type="checkbox"/> Executable Object Code												
6. Description of Action <p>The following actions were taken to correct inaccuracies and deficiencies in the Pluto code pertaining to problem report #28.</p> <p>All Pluto source code files have been retrieved again from the SUN system where they are deposited by the programmer before transferring into CMS on the VAX system. The following File Transfer Protocol (FTP) command was used to get the files:</p> <p style="margin-left: 40px;">mget *.for</p> <p>The FTP session was initiated on the VAX using its default FTP settings. The following files were transferred to a VAX directory:</p> <div style="margin-left: 40px;"> AECLP.FOR ARSP.FOR ASP.FOR CLPSF.FOR CONSTANTS.FOR CP.FOR CRCP.FOR EXTERNAL.FOR GP.FOR GPSF.FOR GSP.FOR GUIDANCE_STATE.FOR PLUTO.FOR RECLP.FOR RUN_PARAMETERS.FOR SENSOR_OUTPUT.FOR SPSF.FOR TDLRSP.FOR TDSP.FOR TSP.FOR UTILITY.FOR </div>												
7. Was the action related to another action(s)? <table style="width: 100%; border: none;"> <tr> <td style="width: 33%;"><input type="checkbox"/> Yes</td> <td style="width: 67%;">AR#(s)</td> </tr> <tr> <td><input checked="" type="checkbox"/> No</td> <td></td> </tr> <tr> <td><input type="checkbox"/> I don't know</td> <td></td> </tr> </table>				<input type="checkbox"/> Yes	AR#(s)	<input checked="" type="checkbox"/> No		<input type="checkbox"/> I don't know				
<input type="checkbox"/> Yes	AR#(s)											
<input checked="" type="checkbox"/> No												
<input type="checkbox"/> I don't know												

Appendix F: Support Documentation Change Reports for the Guidance and Control Software Project

This document was produced as part of Guidance and Control Software (GCS) Project conducted at NASA Langley Research Center. Although some of the requirements for the Guidance and Control Software application were derived from the NASA Viking Mission to Mars, this document does not contain data from an actual NASA mission.

Support Documentation Change Report

page 1 of 1

1. Configuration Item Verification Plan	2. Date 7/27/93	3. Formal Modification #: <u>1</u>
4. Part of Configuration Item Affected: Appendix Design Review Checklist		
5. Reason for Modification: It was discovered during a Design Review the following modification was needed to identify cases where input/output variables may be used in a process, but are not defined by the process where they are used.		
6. Modification: In the Data Usage section, add item number 7. 7. Are all the input/output variables of a process defined in the INPUT/OUTPUT section of the design P-SPEC for that process?		
7. SQA Signature & Date:	Original Signed by Carlos Liceaga <u>7/27/93</u>	

Support Documentation Change Report

page 1 of 1

1. Configuration Item Verification Plan	2. Date 7/29/93	3. Formal Modification #: 2
4. Part of Configuration Item Affected: Appendix Design Review Checklist, Date Usage section, item #3		
5. Reason for Modification: In order to comply with the Software Development Standards change to Design Documentation section, subsection II. Design Structure, paragraph e) Data Dictionary regarding additional variables in the design.		
6. Modification: Data Usage 3. If the design includes variables in addition to the global data store variables defined in the GCS specification, and these variables represent flows between processes, are they included in the design data dictionary?		
7. SQA Signature & Date: <div style="display: flex; justify-content: space-between; align-items: center;"><div>Original Signed by Carlos Liceaga</div><div><u>7/29/93</u></div></div>		

Support Documentation Change Report

page 1 of 1

1. Configuration Item: <u>VERIFICATION PLAN</u>	2. Date: <u>8/6/93</u>	3. Formal Modification #: <u>3</u>
4. Part of Configuration Item Affected: <u>DESIGN REVIEW OVERVIEW AND DESIGN REVIEW PROCEDURES</u>		
5. Reason for Modification: <u>Change in moderator duties + person who is the moderator will change.</u>		
6. Modification: <u>1. Change moderator to project leader</u> <u>2. Remove SQA duties from moderator duties</u> <u>3. Correct typos</u> <u>Corrected pages are attached with corrections marked.</u> <u>new corrections of pages 3, 5 & 6 are included with this report</u>		
7. SQA Signature & Date:	Original Signed by Carlos Liceaga <u>8/13/93</u>	

Original Signed by
George Finelli

8/6/93

Support Documentation Change Reportpage 1 of 2

1. Configuration Item: Software Verification Plan	2. Date: 109/09/93	3. Formal Modification #: 4
4. Part of Configuration Item Affected: Design Review Procedures		
5. Reason for Modification: Change in SQA role in Design Review Procedures		
6. Modification: Corrections were made to the Review Team members, removing the SQA from the team. The SQA was also removed from the Inspector section of the document.		
7. SQA Signature and Date: Original Signed by George Finelli <u>9/21/93</u>		

Support Documentation Change Report

page 1 of 1

1. Configuration Item: Software Verification Plan	2. Date: 12/28/93	3. Formal Modification #: 5
4. Part of Configuration Item Affected: Code Review Sections		
5. Reason for Modification: Insert the documentation for Code Review Overview, Code Review Procedures and Code Review Checklist. Correction to the Inspection Log in order to distinguish between the different Inspections, Design and Code.		
6. Modification: Added the documentation for Code Review Overview, Code Review Procedures and Code Review Checklist. (see attached sheets) Correction to the Inspection Log in order to distinguish between the different Inspections, Design and Code. (see attached sheet)		
7. SQA Signature & Date: Original Signed by <u>3/14/94</u> George Finelli		

Support Documentation Change Report

page 1 of 35

1. Configuration Item: Software Verification Plan	2. Date: 3/17/94	3. Formal Modification #: 6
4. Part of Configuration Item Affected: The Design Review Procedures and Code Review Procedures will be modified into one section called the Review Procedures. The Test Phase documentation will be added.		
5. Reason for Modification: There was too much repetitious information in the Design Review Procedures and the Code Review Procedures, so a new combined section, The Review Procedures, will be added. The Testing Plan will be added as well as a copy of the Problem Report. The font and page formatting were changed to make the document more readable. The copy of the PR document will be added later, due to formatting problems. <i>Kelly 5/2/94</i>		
6. Modification: A new version of the Software Verification Plan has been created. This new version of the Review Procedures replace the Design Review Procedures and the Code Review Procedures, eliminating the redundancies in these documents. The Testing Plan, PR form were added. Modification to the Traceability Matrix added the Test Case column. General clean up was also performed, including formatting and font changes. Corrections attached.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <i>— 5/2/94</i>		

Support Documentation Change Report

page 1 of 1

1. Configuration Item: Software Verification Plan	2. Date: 5/31/94	3. Formal Modification #: 7
4. Part of Configuration Item Affected: A table of content will be added into the document and all the text rearranged to conform with the table of contents.		
5. Reason for Modification: The current plan does not contain all topics and considerations required by DO-178B. The Test Overview section will be reorganized into Testing Activities. The Transition Criteria section and Reverification Guidelines section will be added. This modification will make the plan more accurately reflect the requirements listed in DO-178B for a verification plan.		
6. Modification: A table of contents has been added. Portions of the document have been reorganized to correspond with the table of contents and to address the issues required by DO-178B. Specifically, The Verification Methods section has replaced the Review and Analysis Overview and the Test Overview Sections. References are cited for verification tool descriptions and accordingly added to the reference listing. The Traceability Matrix has been updated.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <u>8/8/94</u>		

Support Documentation Change Report

page 1 of 1

1. Configuration Item: Software Verification Plan	2. Date: 12/6/94	3. Formal Modification #: 8
4. Part of Configuration Item Affected: 1. Testing Activities section of the document 2. Traceability Matrix 3. Table of contents		
5. Reason for Modification: 1. Make the Testing section of this document consistant with The Software Cases and Procedures document. 2. Traceability Matrix 3. Add a useful table of contents		
6. Modification: References to the Software Verification Cases and Procedures document were added, because this document did not exist when the Software Verification Plan document was created. The Traceability Matrix has been updated and expanded. The old copy in the existing Software Verification Plan was replaced. All references to Appendix F & G were removed as these are now covered in the Software Verification Cases and Procedures documents. A new improved table of contents was added.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst F-9 12/8/94		

Support Documentation Change Report

page 1 of 1

1. Configuration Item: Verification Cases and Procedures Document	2. Date: 12-21-94	3. Formal Modification #: 2
4. Part of Configuration Item Affected: Test case development procedure and test case execution procedure.		
5. Reason for Modification: DO-178B requires test cases and procedures for high-level requirements. Test case development and execution procedures will be clarified. Trajectory testing needs to be added.		
6. Modification: 1) The test case development procedure has been modified to include step by step procedure for regenerating test-input and expected results files. 2) The trajectory test development procedure has been added 3) Tables listing all the files involved in the testing process has been added. 4) Filenames used in the procedure have been checked for consistency with CMS.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 9/13/95		

Support Documentation Change Report

page 1 of 1

1. Configuration Item: Software Verification Plan	2. Date: 4/19/95	3. Formal Modification #: 9
4. Part of Configuration Item Affected: 1. Test Coverage Overview 2. Appendix A 3. Table of contents		
5. Reason for Modification: The Verification Plan should be modified so that it contains test coverage issues and no procedural descriptions. Trajectory testing should be addressed in the document. The Table of Content must be updated to reflect this change. The list of authors need to be updated.		
6. Modification: The verification plan has been modified to address coverage issues. All procedural information has been moved to the Verification Cases document. The table of contents has been changed accordingly. The author list has been updated.		
7. SQA Signature & Date:	Original Signed by Kelly Hayhurst	4/13/95

Support Documentation Change Report

page 1 of 1

1. Configuration Item: Configuration Management Plan	2. Date: 8/31/93	3. Formal Modification #: <u>1</u>												
4. Part of Configuration Item Affected: Table 8: Configuration Identification for the DO178-B Life Cycle Data														
5. Reason for Modification: Clarification of configuration items.														
6. Modification: <p>The Design Description has been broken into two configuration items for configuration management purposes; they will be maintained in the same CMS library under different element names. Also, since the Spec had formal mods written before the SDCR form was in place, the CM Plan needs to reflect this.</p> <p>Old Text:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 40%;">Design Description*</td> <td style="width: 40%;">Design Description</td> <td style="width: 20%;">11.10</td> </tr> <tr> <td>Problem and Action Reports*</td> <td>Problem Reports</td> <td>11.17</td> </tr> </table> <p>Modified text:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 40%;">Teamwork Model*</td> <td style="width: 40%;">Design Description</td> <td style="width: 20%;">11.10</td> </tr> <tr> <td>Design Overview*</td> <td>Problem Reports</td> <td>11.17</td> </tr> </table> <p>** Formal modifications 2.2-1 through 2.2-26 of the GCS Specification were not recorded on a Support Documentation Change Report (SDCR) form. All remaining modifications to the GCS Spec will be recorded on a SDCR form.</p>			Design Description*	Design Description	11.10	Problem and Action Reports*	Problem Reports	11.17	Teamwork Model*	Design Description	11.10	Design Overview*	Problem Reports	11.17
Design Description*	Design Description	11.10												
Problem and Action Reports*	Problem Reports	11.17												
Teamwork Model*	Design Description	11.10												
Design Overview*	Problem Reports	11.17												
7. SQA Signature & Date: Original Signed by <u>Carlos Liceaga</u> <u>9/1/93</u>														

Support Documentation Change Report

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1. Configuration Item: Configuration Management Plan	2. Date: 5/18/94	3. Formal Modification #: 2
4. Part of Configuration Item Affected: Entire document		
5. Reason for Modification: Need to change number of implementations from three to two and remove any references to Earth implementation.		
6. Modification: <p>OLD (section "The Role of SCM in the GCS Project"):</p> <p>The GCS project involves independent production of three implementations of a guidance and control application where the development process for each implementation follows the DO-178B guidelines. The three GCS implementations are referred to by planetary names: Mercury, Earth, and Pluto. When there is a need to distinguish multiple implementations, the word <i>planet</i> will be used to refer to Mercury, Earth, or Pluto. For this project, the configuration environment and activities must provide for the management of the life cycle data for one development process and must also provide a mechanism to preserve the independence of the life cycle data for the multiple implementations. This plan will address the configuration management process for life cycle data from all three GCS implementations.</p> <p>NEW:</p> <p>The GCS project involves independent production of two implementations of a guidance and control application where the development process for each implementation follows the DO-178B guidelines. The two GCS implementations are referred to by planetary names: Mercury and Pluto. When there is a need to distinguish multiple implementations, the word <i>planet</i> will be used to refer to Mercury or Pluto. For this project, the configuration environment and activities must provide for the management of the life cycle data for one development process and must also provide a mechanism to preserve the independence of the life cycle data for the multiple implementations. This plan will address the configuration management process for life cycle data from both GCS implementations.</p>		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 5/18/94		

Support Documentation Change Report Continuation

page 2 of 2

a. Report #: Fm 2 for C'm Plan

b. Notes/Explanation (Please reference appropriate section number):

OLD (section "SCM Environment"):

Since three GCS implementations are being independently developed, there will be data from each of the three implementations in some cases. For example, each implementation will have its own source code (e.g., Mercury Source Code, Earth Source Code, and Pluto Source Code).

NEW:

Since two GCS implementations are being independently developed, there will be data from each of the implementations in some cases. For example, each implementation will have its own source code (e.g., Mercury Source Code and Pluto Source Code).

Support Documentation Change Report

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1. Configuration Item: Configuration Management Plan	2. Date: 5/18/94	3. Formal Modification #: 3
4. Part of Configuration Item Affected: Entire document		
5. Reason for Modification: The source code phase is no longer transitional; therefore, need to remove references to transitional source code phase and modify text appropriately.		
6. Modification: Modification 1: Deleted the term "transitional" from the phrases "transitional coding" and "transitional software coding" in 4 occurrences: twice in section The Role of SCM in the GCS Project of the Introduction and twice in section Baselines and Traceability of the SCM Activities. Modification 2: Deleted reference to Post-Code Review version of code in 6 occurrences: once in section Procedures for Using CMS of the SCM Environment, three times in section Baselines and Traceability of the SCM Activities, and twice in Transition Criteria. Modification 3: The transitional software design process is complete when the design has been verified and approved by the SQA. The coding phase is complete when the code has been verified and approved by the SQA (in section The Role of SCM in the GCS Project of the Introduction). Modification 4: The source code libraries and the executable object code libraries will start after the design phase is completed instead of being created from the Post-Code Review version received from RTI (in section CMS Libraries of the SCM Environment). Modification 5: Removed RTI Post-Code Review and Original Transition Code milestones from the source code baselining schedule (in section Baselines and Traceability of the SCM Activities). Modification 6: Changed source code and executable object code transition criterion from Post-Code Review version received from RTI to Design Phase Completion in Table 9.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 5/19/94		

Support Documentation Change Report

page 1 of 2

1. Configuration Item: Configuration Management Plan	2. Date: 5/19/94	3. Formal Modification #: 4
4. Part of Configuration Item Affected: Entire document		
5. Reason for Modification: 1. Remove references to concurrent/noconcurrent qualifier in CMS libraries. The Configuration Manager now uses DECwindows interface with CMS which works differently than the CMS subsystem command level which was previously used. 2. Change the information the GCS participants must supply the CM. 3. Change Configuration Manager's room number. 4. Remove reference to current GCS specification version (otherwise, the CM Plan would have to be updated with each new Spec version). 5. Miscellaneous mods: grammatical errors, spacing in tables, etc.		
6. Modification: Modification 1. Removed references to the concurrent/noconcurrent qualifier. A) Removed the following statements : <ul style="list-style-type: none">• All elements in the CMS libraries will have the concurrent qualifier disabled; this will ensure that two project participants are not working on the same element at the same time and making separate changes to the element (from section CMS Description).• The element is marked within the CMS library that it is reserved so that no other concurrent reservations may be made during this time (from section CMS Description).• As elements are created, they will have the "noconcurrent" qualifier enabled. This means that only one reservation of an element may exist at one time; this will ensure that two project participants are not working on the same element at the same time and making separate changes to the element (from section Procedures for Using CMS). B) Removed the noconcurrent qualifier from CMS example in section Procedures for Using CMS. Modification 2. Removed "CMS library name" from information provided to the Configuration Manager when requesting a reservation in 3 occurrences: once in the section Procedures for Using CMS, once in the section Change control, and once in the section Change Review. Modification 3. Now refer to "Configuration Manager's office" instead of specific room number. Changed once in the section Other SCM Tools and twice in the section Configuration Status Accounting.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 5/20/94		

Support Documentation Change Report Continuation

page 2 of 2

a. Report #: 4, for the Configuration Management Plan

b. Notes/Explanation (Please reference appropriate section number):

Modification 4. Removed reference to current GCS specification in the following paragraph:

In some cases, a new baseline may be established for a support document if numerous modifications have been made (since no predefined milestone exists). For example, when the GCS specification was first developed, Version 1.0 was created. There were a few interim versions of the GCS specification (Version 1.1, 1.2, etc.) created before it was classified as Version 2.0. After verification of the GCS specification, it was updated to Version 2.0. After a significant number of specification modifications, the GCS specification was updated to Version 2.1. **Now that the GCS project has been transferred to NASA, numerous modifications have been made to the GCS specification and it is now at Version 2.2.** (in the section Baselines and Traceability)

Replaced the bolded sentence with: **Upon transfer to NASA, a number of significant modifications were made to the GCS specification, and Version 2.2 was released at the end of the transitional software requirements development phase.**

Modification 5. Miscellaneous mods.

- Removed "CC1" from the titles of Table 3 and Table 4.
- Changed the sentence "In case of an unusual occurrence, a red "*" will be entered in the log with a number associated with it; an explanation of this occurrence will be on a separate page in the binder." to "In case of an unusual occurrence, a "*" will be entered in the log with an explanation of the occurrence." in the section Configuration Status Accounting because the status logs are also available via Excel spreadsheets.
- grammatical errors corrected
- realigned some tables

The following paragraph should have been modified with SDCR #3 for the Configuration Management Plan:

OLD:

The support documents enter CMS when the initial draft of the document has been approved by the SQA representative, with the exception of the GCS specification. The development products enter configuration management process at the Post-Code Review version received from RTI (see the chapter "SCM Environment" in this document for a list of the support documentation). Table 9 shows the transition criterion for entering the configuration management process for the project data.

NEW:

The support documents enter CMS when the initial draft of the document has been approved by the SQA representative, with the exception of the GCS specification. The design descriptions enter the configuration management process at the Post-Code Review version received from RTI. The source code and executable object code are generated and then enter the configuration management process after the design phase has been completed. Table 9 shows the transition criterion for entering the configuration management process for the project data.

Support Documentation Change Report

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1. Configuration Item:

Configuration Management Plan

2. Date:

12/19/94

3. Formal Modification #:

5

4. Part of Configuration Item Affected:

Problem and Change Reporting section

5. Reason for Modification:

There have been a number of changes in the procedures that are followed for problem reporting. This needs to be reflected in the document.

6. Modification:

The following section and figures were modified to show that the project leader has control of the assignment of PR's.

- Instructions for Problem and Action Reports
- Figures 3: Flow of Problem Reporting Process for the Development Products
- Problem Reporting for Support Documentation
- Figure 5: Flow of Change Reporting Process for the Support Documentation
- Completing the Problem Report Form
- Completing the Action Report Form
- Completing the Support Documentation Change Report Form

(See the attached text for the updated changes.)

7. SQA Signature & Date:

Original Signed by
Kelly Hayhurst

12/22/94

Support Documentation Change Report

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1. Configuration Item: CM Plan	2. Date: 1/25/95	3. Formal Modification #: 6
4. Part of Configuration Item Affected: Entire document		
5. Reason for Modification: <ol style="list-style-type: none"> remove reference to SQA having access to CMS libraries reflect the fact that the "replace" command is executed after SQA signs PR update library names to reflect current naming need to clarify that verification cases library is not planet specific status log sheet has been modified change SQA to project leader in a few cases cosmetic changes adding references on how to fetch, reserve, and replace an element using CMS 		
6. Modification: <ol style="list-style-type: none"> Remove reference to SQA having access to CMS libraries in the sections "CMS Description" and "Procedures for Using CMS" New Text for Replace command in section "CMS Description": As in the example where the programmer has reserved an element to make a change in response to a Problem Report, the element will be replaced after the SQA representative has signed the PR indicating all necessary changes have been made. In the section "CMS Libraries", Table 7 removed reference to the Software Verification Cases and the Software Verification Procedures being planet specific from the library names. The following text was added to the footnote at the end of Table 7 in the section "CMS Libraries": * These project data are implementation specific. The Verification Cases library only has a few elements that are implementation specific; therefore, there will be a naming convention to distinguish between the two implementations. In the section "Configuration Identification", the following was added for clarification: For implementation specific data, some elements in the libraries may have the same names. Since each implementations' elements are mainly kept in separate libraries there will be no confusion as to which elements are being referenced; however, for the verification cases, some elements are distinguished by preceding the element name with the first letter of the planet name followed by an underscore. For example, the guidance processing test case for Mercury would be named m_test_gp.for. In the section "Configuration Status Accounting", updated the description and illustration of the status log sheet to reflect the one that is currently being used. In the section "Change Control", removed text referring to SQA in the following: (a) Approval of the procedure by the (SQA representative and) project leader is required prior to implementing the procedure; (b) Because this tool directly affects the output from the testing, any change to the simulator would require regression testing and approval by (the SQA representative and) the project leader. In the section "Transition Criteria", changed SQA to project leader in the following: (a) The software life cycle data that requires approval by the project leader will enter the configuration management process after approval has been received and (b) The support documents enter CMS when the initial draft of the document has been approved by the project leader, with the exception of the GCS specification minor wording in various sections 		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 2/24/95		

Support Documentation Change Report Continuation

page 2 of 2

a. Report #: 6

b. Notes/Explanation (Please reference appropriate section number):

8. Deleted the old contents of the section "Procedures for Using CMS", and added new text explaining how to fetch, reserve, and replace elements. The new section follows:

Procedures for Using CMS

The configuration manager will use CMS libraries to manage project data. CMS can be invoked from the DCL command level, from the CMS subsystem command level, or from the DECwindows user interface.

In order to fetch, reserve or replace an element using CMS, it is easiest to have the directory set to the specific directory in which the element will be placed or retrieved. The fetch command is issued when a copy of the element is needed for examination purposes only; no changes may be made to this copy of the element. For example, after issuing the fetch command, the element name is entered in the appropriate place. If this transaction needs to be recorded in the history log, a remark must be entered before the command is executed; otherwise, no transaction will be recorded. Once the fetch command has been issued, the element will reside in the VMS default directory that was set prior to issuing the command. The reserve and replace commands work in a similar manner, except these transactions are always recorded in the history log, even if no remark is entered along with the command. The reserve command places a working copy of the element in the directory; the latest version of the element is reserved unless otherwise specified. If the noconcurrent qualifier was issued at the time of reservation, no other reservations of that element are allowed until after the element has been replaced. Once the reserve command has been issued, the element name is entered, along with a remark, and then the reservation is executed. The replace command can only be executed if a reservation exists. The replace command, along with the element name and remark, are entered and executed. If there is more than one version of a file in the default directory, the replace command will use the highest version number for the replacement of an element.

The wildcard character, "*", may be used for multiple reservations, replacements, or fetches if the elements are similar in name. The * may be used in place of one or more characters.

The following section describes the tool *teamwork*, which will be used by the programmers for the development of their detailed designs in addition to CMS.

Support Documentation Change Report

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1. Configuration Item Software Development Standards	2. Date 7/27/93	3. Formal Modification #: 1
4. Part of Configuration Item Affected: Chapter: Software Design Standards, Section: Design Documentation, II e)		
5. Reason for Modification: Need to clarify the wording regarding the contents of the Data Dictionary. Propose that the Data Dictionary should contain all entries from the Data Dictionary in the GCS specification and any additional variables contained in the design that represent data flows between processes.		
6. Modification: Action: Replace the following text with the modified text. e) Data Dictionary This subsection should contain a complete data dictionary, including both specified and non-specified variables. This subsection may also contain all the information pertaining to resource limitations, such as memory and timing constraints. Modified Text: e) Data Dictionary This subsection should contain the data dictionary for the teamwork design. This data dictionary should include all of the data dictionary entries in the GCS specification and any additional variables contained in the design that represent flows between processes. This subsection may also contain all the information pertaining to resource limitations, such as memory and timing constraints.		
7. SQA Signature & Date: Original Signed by Carlos Liceaga 7/28/93		

Support Documentation Change Report

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Configuration Item: Software Development Standards	2. Date: 8/30/93	3. Formal Modification #: 2
4. Part of Configuration Item Affected: Chapter: Problem and Change Reporting Section: Instructions for Problem and Action Reports, first paragraph		
5. Reason for Modification: Need to make explicit the concept that during verification activities where a Moderator is present, the Moderator will have the authority to make the final determination as to whether issuing a Problem Report is appropriate; that is, during such verification activities, it will not be the case that any project participant can initiate a Problem Report.		
6. Modification: Action: Modified the sentence below to clarify who has the authority to initiate Problem Reports Original Text: During the development cycle, any participant in the project (programmer, verification analyst, SQA representative, or system analyst) who identifies or observes something that may need to be changed in some way in a development product is responsible for initiating a Problem Report. Modified Text: In general, a project participant who identifies, in the course of their prescribed activities, something in a development product that may be regarded as a problem (such as a violation of a software requirement or project standard) is responsible for initiating a Problem Report. However, during those verification activities where a Moderator is present, the Moderator will have the authority to determine whether issuing a Problem Report is appropriate.		
7. SQA Signature & Date:		

Original Signed by
George Finelli

8/24/93

Support Documentation Change Report

page 1 of 1

Configuration Item: Software Development Standards	2. Date: 8/30/93	3. Formal Modification #: 3
4. Part of Configuration Item Affected: Chapter: Problem and Change Reporting Section: Instructions for Problem and Action Reports, item 1.		
5. Reason for Modification: Need to clarify that during verification activities where a Recorder is present, the Recorder will be the actual initiator of the Problem Reports. <i>Decided a different modification was more important. Had the configuration manager 'unreserve' this configuration item.</i>		
6. Modification:		
7. SQA Signature & Date:		

Original Signed by
George Finelli

8/31/93

Support Documentation Change Report

page 1 of 1

1. Configuration Item:

Software Development Standards

2. Date:

1/3/94

3. Formal Modification #:

3

4. Part of Configuration Item Affected:

Chapter: Problem and Change Reporting

Sections: Instructions for Problem and Action Reports, Completing the Problem Report Form, Completing the Action Report Form, Problem Reporting for Support Documentation, Completing the Support Documentation Change Report, Figure 6, and Figure 8

5. Reason for Modification:

The GCS project leader has assumed some of the responsibilities associated with the Problem and Action reporting that had been delegated to the SQA representative. The project leader will now be the first point of contact for Problem and Action Reports and Support Documentation Change Reports. The project leader will give the initial approval to make the change, assign report numbers, and distribute forms to the appropriate persons. Need to change the problem reporting procedures to reflect this change.

6. Modification:

To show that several of the problem and action reporting responsibilities that had belonged to the SQA representative now belong to the project leader, the term "SQA representative" was replaced with "project leader" in the appropriate parts in the chapter, "Problem and Action Reporting", along with a few minor wording changes to clarify the process. Those changes have been highlighted and are attached to this form.

7. SQA Signature & Date:

Original Signed by
George Finelli

1/5/94

Support Documentation Change Report

page 1 of 3

1. Configuration Item: Software Development Standards	2. Date: 5/6/94	3. Formal Modification #: 4
4. Part of Configuration Item Affected: The following chapters are affected: section The Software Development Process for the GCS Project of the Introduction , Instructions for Programmers Regarding the Transitional Design Phase, Software Code Standards, Instructions to Programmers Regarding the Transitional Coding Phase		
5. Reason for Modification: Change in project plan: now going to have the programmers generate their own source code for the implementation instead of modifying existing code for the implementation developed at the Research Triangle Institute. The instructions to the programmers during the design and coding phases will change along with the code standards.		
6. Modification: Modification 1: Deleted the term "transitional" from the phrases "transitional coding" and "transitional software coding" in 3 occurrences: once in section The Software Development Process for the GCS Project of the Introduction and twice in Instructions to Programmers Regarding the Transitional Coding Phase Modification 2: Removed the statement "5. modification of the existing code (developed at RTI) to bring it up to the newly revised design" from the Introduction (The Software Development Process for the GCS Project) Modification 3: Deleted the following section from Instructions for Programmers Regarding the Transitional Design Phase: While waiting for their design reviews, the programmers should (given that there is time to do so): <ol style="list-style-type: none">1. Reserve their original Post Code Review version of their coded implementation out of the CMS library after submitting the design to the SQA representative. An element or class of elements can be fetched or reserved from the CMS library by contacting the configuration manager. When requesting an element, be specific about which element is needed, why that element is needed, and whether to reserve or fetch that element. VAX Notes should be used to request elements from CMS. Note that the configuration manager will not release the Post Code Review version of the code until the design description has been submitted for configuration management.2. After reserving the Post Code Review version of the implementation, the programmer should remove (delete) the revision history, all code that was commented out due to changes from previous RTI-generated Problem Reports, and comments associated with those Problem Reports from this version of code. When finished, the code should still have the original descriptive comments in place. No executable code should be deleted or modified at this time. This new version of code will be referred to as the original transition code. To assure that no executable code has been deleted, it is suggested that the programmer use the DIFFERENCES command in VAX/VMS to compare the original Post Code Review version to the original transition code version. The only differences reported as a result of using the DIFFERENCES command should be comments.3. Replace the original transition version of the code back into the appropriate CMS library for the code (by consulting with the configuration manager using VAX Notes) prior to making any other modifications to the code. The elements of the original transition version of code will be put in a baseline for that implementation.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 5/12/94		

Support Documentation Change Report Continuation

page 2 of 3

i. Report #: 4, for the Software Development Standards

b. Notes/Explanation (Please reference appropriate section number):

Section 6. Modification (continued):

Modification 4. Modified the entire section Code Presentation and Documentation in chapter Software Code Standards to the following:

Code Presentation and Documentation

For this GCS project, the programmers are required to follow a few simple guidelines with respect to the presentation and documentation of the source code. With respect to presentation standards (line length, indentation, blank lines, etc.), programmers are only required to make the source code easily readable to aid in verification and future modification. Programmers are encouraged to make generous use of indentation and blank lines, but no specific constraints are imposed. With respect to documentation, each programmer should add descriptive comments to the source code wherever appropriate. The comments should provide sufficient information to allow changes to be made completely, consistently, and correctly while retaining the structure. The following items also are required for the documentation of the source code: module header blocks, a revision history (starting after the first Code Review), and a system for denoting modifications. Below is a brief description of these items.

Module Header Block -- Header blocks should be used at the beginning of each module to provide an overall summary of that module. Figure 3 shows a general format for the module header. Each programmer may choose the exact style of the header block; that is, the style does not have to conform precisely to the style presented in Figure 3, but all of the information should be included.

Revision History -- All modifications made to each module should be summarized in a section called revision history located directly under the header block for that module. Each modification to a module should be labeled with a version number, v#. For example, the first modification to a module would be labeled v1 and the second modification would be v2. The revision history also should contain the Action Report (AR) number associated with each change made to the module, the date the change is made, the name of the person implementing the change, and a description of the change.

Notation of Modifications -- Once the source code is submitted for code review, no code that is to be modified in response to a Problem Report may be deleted. The source code that is to be modified should be commented out (instead of deleted) and the new code added. The beginning of all areas of changes should be noted clearly with a comment line, as shown below, containing the following:

```
!!  
! v# Begin changes for AR#<action report number>. <short description of change>  
!-
```

The end of change areas should be similarly marked by an "End Change" comment line.

Support Documentation Change Report Continuation

page 3 of 3

a. Report #: 4, for the Software Development Standards

b. Notes/Explanation (Please reference appropriate section number):

Modification 4. continued

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!
!   MODULE NAME:
!   PURPOSE:
!   ARGUMENTS:
!   NOTES:
!   AUTHOR:
!   IMPLEMENTATION NAME:
!   DATE FIRST SUBMITTED FOR CONFIGURATION MANAGEMENT:
!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!
!                                     REVISION HISTORY
!   v# , <date>, <author name>, <description, including AR#>
!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

Figure 3. Module Header Block and Revision History

Naming conventions for subprograms, variables, and constants should be understandable (to aid traceability and verification) and conform to requirements in the GCS specification. The specification states specific requirements regarding the labeling of global data stores. The specification also places a constraint on the use of variables in addition to the global data store variables (see the GCS specification for further information). In addition to these constraints, no special coding tools should be used to generate the code. Beyond those stated here, no further constraints have been imposed on the coding process.

Modification 5: Modified the first instruction under Instructions to Programmers Regarding the Transitional Coding Phase from

1. Modify the original transition version of code such that the source code implements the detailed design description and conforms to the Software Coding Standards defined above. Each programmer can reserve the original transition version of code by consulting the configuration manager using VAX Notes. Programmers can start the modification of the original transition version of their code prior to the completion of the Design Reviews. However, the code should not be replaced in CMS or submitted for Code Review before the completion of the Design Review phase (since the Design Reviews can initiate changes to the design description).

to

1. Generate source code that implements the detailed design description and conforms to the Software Coding Standards defined above.

Modification 6: Made minor wording changes in instructions 3 and 4 in Instructions to Programmers Regarding the Transitional Coding Phase. Replaced the word "Replace" with "Submit" in instruction 3; replaced the phrase "to inform him that" to "when" in instruction 4; and deleted the phrase "will determine dates and times for the Code Reviews" from instruction 4.

Support Documentation Change Report

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1. Configuration Item: Software Development Standards	2. Date: 5/16/94	3. Formal Modification #: 5
4. Part of Configuration Item Affected: The following chapters are affected: Introduction, Software Requirements Standards, Software Code Standards, Collecting Effort Data, Communication Protocol, and the Appendix		
5. Reason for Modification: Change in project plan: now only have 2 implementations of the GCS application as opposed to 3 implementations. Need to change all references to 3 implementations and delete references to the Earth implementation (which is the implementation that was dropped).		
6. Modification: Modification 1: Changed the reference to three implementations to multiple implementations in several occurrences: <ul style="list-style-type: none"> (a) in section The Software Development Process for the GCS Project of the Introduction "The GCS project involves the development of three separate implementations ..." was changed to: "The current GCS project involves the development of separate implementations ..."; and added the phrase "and only develop two of the implementations" to the end of the sentence: Due to the transitioning of the project from RTI to NASA along with new focus on the DO-178B guidelines, the decision was made to revisit some of the original development activities. (b) in section Review of the Software Requirements in Software Requirements Standards: "In fact, the three implementations ..." was changed to "In fact, the implementations ..." (c) in section Programming Language in Software Code Standards: "... the three GCS implementations ..." was changed to "... the GCS implementations..." (d) in Collecting Effort Data: "... for the three GCS implementations ..." was changed to "...for the GCS implementations..." (e) in Instructions to the SQA Representative for Recording Effort in the Appendix,; "... the three GCS implementations ..." was changed to "...the GCS implementations..." in 4 places, and "... the three implementations ..." was changed to "...the implementations..." in 1 place. (f) in Instructions to the System Analyst for Recording Effort in the Appendix,; "... the three GCS implementations ..." was changed to "...the GCS implementations..." in 2 places, 		
7. SQA Signature & Date: Original Signed by <u>5/23/94</u> Kelly Hayhurst		

Support Documentation Change Report Continuation

page 2 of 2

a. Report #: 5, for the Software Development Standards

b. Notes/Explanation (Please reference appropriate section number):

Section 6. Modification (continued):

Modification 1: (continued)

- (g) in Instructions to the Configuration Manager for Recording Effort in the Appendix,;
"... the three GCS implementations ..." was changed to "...the GCS implementations..." in 2 places
"... all three implementations ..." was changed to "...all implementations..." in 1 place.

Modification 2: Deleted references to the Earth implementation

- (a) in section Conventions for Communication between Programmers and System Analyst in Communication Protocol, deleted:
SA-Earth-Programmer: contains all communication between the system analyst and the Earth Programmer
- (b) in the table labeled Effort Hours for Software Quality Assurance Activities in the Appendix, deleted the entire section referring to the Earth implementation
- (c) in the section Instructions to the Configuration Manager for Recording Effort Data in the Appendix, changed the phrase "Mercury, Earth, and Pluto" to "Mercury and Pluto"; and, in the table labeled Effort Hours for Configuration Management Activities, deleted the references to the Earth Programmer and Earth Verification Analyst
- (d) in the table labeled Effort Hours for System Analyst Activities in the Appendix, deleted the references to the Consulting for the Earth implementation and Participating in Reviews for the Earth implementation

Modification 3: The forms shown in the Appendix for collecting effort data were originally developed using the MacDraft tool. Replaced the forms done in MacDraft with Word tables. Consequently, there are some minor cosmetic changes to the forms shown, but the content should be the same with the inclusion of the changes described above.

Support Documentation Change Report

page 1 of 3

1. Configuration Item: Software Development Standards	2. Date: 5/23/94	3. Formal Modification #: 6
4. Part of Configuration Item Affected: The following chapters are affected: Software Requirements Standards, Software Design Standards, Problem and Change Reporting, Instructions for Using CMS, Communication Protocol, and the Appendix		
5. Reason for Modification: Originally in the project, any changes to the GCS specification were referred to as "formal modifications". Later in the project, we instituted a system of Support Documentation Change Reports to handle change requests for much of the project documentation, including the GCS specification. The Support Documentation Change Report system was documented in the standards, but many of the references to "formal modifications" were not changed. Need to change the references to the old formal modifications to make them consistent with the Support Documentation Change Report system.		
6. Modification: Modification 1: in section Derived Requirements and Modification in the Software Requirements Standards, changed the first paragraph from: "In general, changes to the GCS specification are made through a system of "formal modifications"*. All questions raised by any member of the development team regarding the GCS specification are brought to the system analyst. The system analyst reviews all questions and determines if changes to the specification are required. When changes are deemed necessary, the system analyst submits a description of the necessary modification to the SQA representative and project leader for review. Figure 2 shows information that is included in the description of the modifications. The chapter "Problem and Change Reporting" gives a more detailed description of the procedures and forms used for tracking, reviewing and approving changes to the GCS specification." * Formal modifications were not issued for the changes made to the GCS specification during the transitional requirements development phase, since a significant number of changes were made during one period. All changes, however, were reviewed and the revised text was denoted in version 2.2 as described in the previous section. All other changes to the GCS specification will be made using the system of formal modifications. to: "According to DO-178B, the GCS specification is classified under control category 1 -- which means that the project must provide a formal system of problem reporting, change control, and change review for that data. All changes to the GCS specification, along with the other project support documentation, are made through a system of Support Documentation Change Reports. All questions raised by any member of the development team regarding the GCS specification are brought to the system analyst. The system analyst reviews all questions and determines if changes to the specification are required. When changes are deemed necessary, the system analyst submits a description of the necessary modification to the SQA representative and project leader for review. The chapter "Problem and Change Reporting" gives a more detailed description of the procedures and forms used for tracking, reviewing and approving changes to the GCS specification." Modification 2: Deleted Figure 2. Formal Modifications to the Requirements; and renumbered the figures accordingly		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst		

5/24/94

Support Documentation Change Report Continuation

page 2 of 3

i. Report #: 6, Software Development Standards

b. Notes/Explanation (Please reference appropriate section number):

Section 6: (continued)

Modification 3: Changed the term "formal modification" to "modification" in the following places:

- (a) 2 occurrences in section Derived Requirements and Modification in the Software Requirements Standards
- (b) 3 occurrences in section Problem Reporting for Support Documentation in Problem and Change Reporting (including changing the Support Documentation Change Report Form)
- (c) 1 occurrence in section Completing the Support Documentation Change Report in Problem and Change Reporting
- (d) 2 occurrences in section General Rules Regarding Topics and Replies in Communication Protocol

Modification 4: Deleted the following sentence from section Design Documentation in Software Design Standards

"If changes, additions, or deletions are made in response to a formal modification, the formal modification number should be referenced."

Modification 5: Deleted the label "Formal Modification for Specification" from Table 2. Configuration Identification for the DO-178B Life Cycle Data.

Modification 6: Changed the following paragraph in section General Rules Regarding Topics and Replies in Communication Protocol from:

"The Topic Source is either the name of the section(s) in the specification or the name of a Formal Modification to the specification, to which the question applies. The specification section names are predefined and appear in Table 7 below. The programmer must use at least the first four characters of the section name if the section name has four or more characters, but may use more if so desired. If the actual section name has less than four characters, then the full section name should be used. In those cases where the first four characters are not unique, substitutions are given in the table below, and those substitutions must be used instead of the actual section name. In each case, the required part of the section name is bolded. If the source of the question is a Formal Modification, then the Topic Source should be "Modx.y-z", where x.y-z is the number of the Formal Modification. If, for some reason, none of the predefined section names nor a Formal Modification number is appropriate, then one should use the substitute name "other" and describe the source in the text part of the topic. In the case where the question applies to more than one source, list all the applicable sources separated by commas."

to:

"The Topic Source is either the name of the section(s) in the specification or the name of a modification to the specification, to which the question applies. The specification section names are predefined and appear in Table 7 below. The programmer must use at least the first four characters of the section name if the section name has four or more characters, but may use more if so desired. If the actual section name has less than four characters, then the full section name should be used. In those cases where the first four characters are not unique, substitutions are given in the table below, and those substitutions must be used instead of the actual section name. In each case, the required part of the section name is bolded. If the source of the question is a Support Documentation Change Report, then the Topic Source should be "Modx.y-z", where x.y-z is the number of the modification. If, for some reason, none of the predefined section names nor a modification number is appropriate, then one should use the substitute name "other" and describe the source in the text part of the topic. In the case where the question applies to more than one source, list all the applicable sources separated by commas."

Support Documentation Change Report Continuation

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1. Report #: 6, Software Development Standards

b. Notes/Explanation (Please reference appropriate section number):

Section 6: (continued)

Modification 7: Changed the term "Formal Modification" to "Support Documentation Change Report" in 2 occurrences in Figure 9. Example of Conversation Between the Programmer (PG) and System Analyst (SA) and in 1 occurrence in Figure 10. Directory of All Notes in the Conversation Example.

Modification 8: In Instructions to the Programmers for Recording Effort in the Appendix, the following changes were made:

- (a) deleted the phrase: "except when a change is made during this time in response to a Formal Modification to the specification." from instruction 2.
- (b) changed the term "formal modification" to "modification" in instruction 3.
- (c) changed instruction 6 from
6. Responding to Formal Modifications: record time spent reading and understanding the formal modification to the GCS specification and making changes to the design or code due to the formal modifications. Effort should be recorded in this category only after the first Design Review.
to:
6. Responding to Modifications to the Requirements: record time spent reading and understanding the Support Documentation Change Reports for the GCS specification and making changes to the design or code due to modifications to the GCS specification. Effort should be recorded in this category only after the first Design Review.
- (d) Changed part 6. to Responding to Modifications to the Requirements in Figure 11. Form for Recording Effort Data for Programmers

Modification 9: In Instructions to the Verification Analysts for Recording Effort in the Appendix, the following changes were made:

- (a) changed the title of instruction 3 from "**Responding to Formal Modifications:**" to "**Responding to Modifications to the Requirements:**" and made the corresponding change in Figure 12. Form for Recording Effort Data from Verification Analysts
- (b) changed the term "formal modification" to "Support Documentation Change Report" in 2 occurrences in instruction 3.
- (c) changed the term "formal modification" to "modification" in the last occurrence in instruction 3.

Modification 10: In Instructions to the SQA Representative for Recording Effort in the Appendix, the following changes were made:

- (a) changed the term "formal modification" to "Support Documentation Change Report" in the first paragraph and in instructions 2 and 3.
- (b) changed the title of instruction 5 from "**Reviewing Formal Modifications:**" to "**Reviewing Modifications to the Requirements:**" and made the corresponding change in Figure 13. Form for Recording Effort Data from the SQA Representative

Modification 11: In Instructions to the System Analyst for Recording Effort in the Appendix, changed the term "formal modification" to "Support Documentation Change Report" in instructions 1 and 3

Support Documentation Change Report

page 1 of 2

1. Configuration Item: Software Development Standards	2. Date: 5/25/94	3. Formal Modification #: 7
4. Part of Configuration Item Affected: Software Design Standards and Instructions to Programmers Regarding the Transitional Design Phase		
5. Reason for Modification: Need to revise the Software Design Standards to eliminate some items not specified by the DO-178B guidelines and not needed as part of the project -- in particular, the requirements to give a call structure, transition history, and revision history as part of the design. Also need to revise the Instructions to the Programmers Regarding the Transitional Design Phase in response to the changes that have been made.		
6. Modification: Modification 1: in the section Design Documentation of the Software Design Standards, deleted the sentence "It is important to note that the design documentation should reference the <i>planetary name</i> of the implementation, but not directly reference the name of the programmer." Modification 2: in the section Design Documentation of the Software Design Standards, deleted section II a) Description of Call Structure. Renumbered the sections accordingly. Modification 3: in the section Design Documentation of the Software Design Standards, added the following sentence to the start of section II c) Module Description: "This section should provide the software architecture and low-level requirements, developed using the <i>teamwork</i> tool, that satisfy the requirements given in the GCS specification." Modification 4: in the section Design Documentation of the Software Design Standards, deleted section III. Transition History. Modification 5 in the section Design Documentation of the Software Design Standards, deleted section IV. Revision History. Modification 6 in the section Design Documentation of the Software Design Standards, changed the section number for References from V to III. Modification 7: in the section Design Documentation of the Software Design Standards, deleted section VI. Appendix.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <u>5/25/94</u>		

Support Documentation Change Report Continuation

page 2 of 2

i. Report #: 7, Software Development Standards

b. Notes/Explanation (Please reference appropriate section number):

Section 6: (continued)

Modification 8: in the Instruction to Programmers Regarding the Transitional Design Phase, changed:

"Within this transitional phase, special instructions, such as including a section describing the Transition History in the design documentation standards, and modifying an existing design, have been included to provide guidance to the project programmers due to the special circumstances of this period."

to:

"Within this transitional phase, special instructions for modifying the existing design have been included to provide guidance to the project programmers due to the special circumstances of this period."

Modification 9: in the Instructions to Programmers Regarding the Transitional Design Phase, changed:

"1. Modifying the original design of their implementation (developed at RTI) so that the new detailed design meets the requirements of version 2.2 of the GCS specification and the standards set forth in this document in the chapter "Software Design Standards". As described in the design standards, the CASE tool, *teamwork* should be used to update the design to reflect the functionality in version 2.2 of the specification prior to making modifications to the code."

to:

"1. Modifying the original design of their implementation (developed at RTI) so that the new detailed design meets the requirements of the most current version of the GCS specification and the standards set forth in this document in the chapter "Software Design Standards". As described in the design standards, the CASE tool, *teamwork*, should be used to update the design."

Modification 10: in item 4. of the Instructions to Programmers Regarding the Transitional Design Phase, changed the references to the SQA representative to the project leader.

Modification 11: in item 4. of the Instructions to Programmers Regarding the Transitional Design Phase, changed the phrase:

"will determine dates and times for the Design Reviews and contact the participants in the review to schedule the review sessions."

to:

"will contact the participants in the review to schedule the review sessions."

Support Documentation Change Report

page 1 of 1

1. Configuration Item: Software Development Standards	2. Date: 5/25/94	3. Formal Modification #: 8
4. Part of Configuration Item Affected: Software Requirements Standards		
5. Reason for Modification: The paragraph at the end of the section Review of the Software Requirements discusses the bolding used to highlight changes when we went to version 2.2 of the specification. Since we have since revised the specification and removed the bolding, this paragraph is no longer appropriate.		
6. Modification Deleted the following paragraph from the end of the section Review of the Software Requirements in the Software Requirements Standards: Version 2.2 of the GCS specification contains a number of modifications to version 2.1 of the specification document. To help identify changes made during the enhancement of the specification, the text that was modified from version 2.1 was bolded in version 2.2. Some existing text was moved to another place in the document, and some text was deleted. There is no demarcation in version 2.2 to indicate where text was moved or deleted. The modifications that are significant (may impact the coding of an implementation) are marked with a footnote number. Where there were a number of significant modifications within a processing step (in Level 3 of the specification), a footnote number was placed just at the top of the processing step (as opposed to marking each individual change within the processing step). There was also a significant new addition to the specification: requirements for exception handling. New additions to the text were also bolded.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 5/25/94		

Support Documentation Change Report

page 1 of 1

1. Configuration Item: Software Development Standards	2. Date: 5/25/94	3. Formal Modification #: 9
4. Part of Configuration Item Affected: Instructions for Using CMS and the Appendix		
5. Reason for Modification: In SDCR #4, changed the project plan to have the programmers generate their own source code for the implementation instead of modifying existing code for the implementation developed at the Research Triangle Institute. However, some text in the Instructions for Using CMS and the Appendix still contains language about using the old code from RTI and needs to be corrected.		
6. Modification Modification 1: Deleted the last paragraph, shown below, in the section Basic CMS Commands in the chapter Instructions for Using CMS: Prior to the first code review, a programmer can reserve a copy of the original transition version of code and make changes so that the source code implements the design description and conforms to the Software Coding Standards. While the specific element generations making up the original transition code are reserved, the programmers are allowed to make as many changes as needed without replacing the element after each change. However, once the code has been submitted for Code Review, changes to the code can be made only in response to a Problem Report. In addition, the source code element should be reserved and replaced with each individual change. The Action report for each change should be noted in the comment for that reservation. Modification 2: Added the sentence below to the new last paragraph in the section Basic CMS Commands in the chapter Instructions for Using CMS "The report number for each change should be noted in the comment for that reservation." Modification 3: in the Instructions to the Programmers for Recording Effort in the Appendix, changed instruction 2 from: "2. Changing Code during Transitional Coding Phase: record time spent updating the existing software code to match the detailed design description. This will include all time spent modifying the code until the time of the first Code Review. " to "2. Developing Source Code: record time spent developing source code to meet the detailed design description. This will include all time spent generating the source code until the time of the first Code Review."		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 5/25/94		

Support Documentation Change Report Continuation

page 2 of 2

a. Report #: 9, for the Software Development Standards

6. Modification

Section 6: (continued)

Modification 4: in the Instructions to the Programmers for Recording Effort in the Appendix, changed the label for instruction 2 in Figure 11. Form for Recording Effort Data from Programmers to "2. Developing Source Code"

Modification 5: in the Instructions to the Verification Analysts for Recording Effort Data in the Appendix, changed the phrase "Transitional Coding Phase" to "Coding Phase" in 3 occurrences in Figure 12. Form for Recording Effort Data from Verification Analysts

Software Requirements GCS Development Specification

Formal Modification # 2.2-1

Date: December 30, 1992

Part of Specification Affected:

Chapter 5

AECLP

Page 38

Section labeled "PROCESSING WHEN AXIAL ENGINES ARE ON"

Last sentence of the first paragraph

Reason for Modification:

The statement pertaining to the initialization of PE_INTEGRAL, YE_INTEGRAL, and TE_INTEGRAL needs to be corrected. If the trajectory begins with FRAME_COUNTER set to one, then these variables will be initialized to zero; however, if the FRAME_COUNTER begins at a value other than one, these variables may be initialized to a value other than zero.

Modification:

Original Text:

"The variables PE_INTEGRAL, YE_INTEGRAL, AND TE_INTEGRAL will be initialized to the value zero by INIT_GCS."

Action:

- Delete the text "to the value zero"

Modified Text:

"The variables PE_INTEGRAL, YE_INTEGRAL, AND TE_INTEGRAL will be initialized by INIT_GCS."

Software Requirements GCS Development Specification

Formal Modification # 2.2-2

Date: December 30, 1992

Part of Specification Affected:

Chapter 5

RECLP

Page 65

Section labeled "DETERMINE PULSE INTENSITY AND DIRECTION"

Third sentence from the end of the paragraph

Reason for Modification:

The statement pertaining to the initialization of the variable THETA needs to be corrected. The variable THETA will be initialized to the initial roll angle which is not necessarily zero.

Modification:

Original Text:

"The variable THETA will be initialized to the value zero by INIT_GCS."

Action:

- Delete the text "to the value zero"

Modified Text:

"The variable THETA will be initialized by INIT_GCS."

Software Requirements GCS Development Specification

Formal Modification # 2.2-3

Date: December 30, 1992

Part of Specification Affected:

Chapter 5

AECLP

Page 41

Section labeled "COMPUTE AXIAL ENGINE VALVE SETTINGS"

Last sentence in the section

Reason for Modification:

The wording "to the nearest integer" needs more specificity.

Modification:

Original Text:

"with INTERNAL_CMD between 0 and 1.0 being converted *linearly* (to the nearest Integer)²⁷ to a value of AE_CMD between 0 and 127."

Actions:

- Delete the text " (to the nearest Integer)²⁷ "
- Add new text which will then become the last sentence in the section. The new sentence is shown below under "Text to be Added".

Text to be Added:

"Each value for AE_CMD is to be rounded to the nearest integer, where rounding is defined as follows:²⁷

Let x represent the real value that is to be rounded

Then, $AE_CMD = \text{the Integer part of } (x + 0.5)$ "

Modified Text:

"with INTERNAL_CMD between 0 and 1.0 being converted *linearly* to a value of AE_CMD between 0 and 127. Each value for AE_CMD is to be rounded to the nearest integer, where rounding is defined as follows:²⁷

Let x represent the real value that is to be rounded

Then, $AE_CMD = \text{the Integer part of } (x + 0.5)$ "

Software Requirements GCS Development Specification

Formal Modification # 2.2-4

Date: February 8, 1993

Part of Specification Affected:

Chapter 5

GP

Page 60

Table 5.10

First line of the table (GP_PHASE = 1), under the column labeled "EVENT"

Reason for Modification:

The phrase "**and engines were not turned off in prior frame**" is unnecessary because when the lander is in Phase 1, the engines will not yet have been turned off.

Modification:

Original Text:

"Altitude for turning engines on is sensed **and engines were not turned off in prior frame**"

Action:

- Delete the text "**and engines were not turned off in prior frame**"

Modified Text:

"Altitude for turning engines on is sensed"

Software Requirements GCS Development Specification

Formal Modification # 2.2-5

Date: February 24, 1993

Part of Specification Affected:

Chapter 5

ARSP

Page 43

INPUT (list of variables that are inputs to this processing module)

Reason for Modification:

The variable FRAME_COUNTER was omitted from the list of inputs.

Modification:

Original Text:

INPUT

AR_ALTITUDE AR_FREQUENCY K_ALT	AR_COUNTER AR_STATUS
--------------------------------------	-------------------------

Action:

- Add the variable FRAME_COUNTER to the list of inputs.

Modified Text:

INPUT

AR_ALTITUDE AR_FREQUENCY FRAME_COUNTER	AR_COUNTER AR_STATUS K_ALT
--	----------------------------------

Software Requirements GCS Development Specification

Formal Modification # 2.2-6

Date: March 10, 1993

Part of Specification Affected:

Chapter 6, Data Requirements Dictionary
PART I. DATA ELEMENT DESCRIPTIONS
Page 89 (GVE)
Page 91 (PE_MAX and PE_MIN)
Page 94 (TE_MAX and TE_MIN)
Page 95 (YE_MAX and YE_MIN)

Reason for Modification:

The DATA TYPE for GVE should be "real*8" instead of "array(1..2) of real*8".

The DATA TYPE for PE_MAX, PE_MIN, TE_MAX, TE_MIN, YE_MAX, and YE_MIN should be "array(1..2) of real*8" rather than "real*8"

Modification for GVE:

Original Text:

DATA TYPE: array(1..2) of real*8

Action:

- Delete "array(1..2) of" before "real*8"

Modified Text:

DATA TYPE: real*8

Modification for PE_MAX, PE_MIN, TE_MAX, TE_MIN, YE_MAX and YE_MIN:

Original Text:

DATA TYPE: real*8

Action:

- Insert "array(1..2) of" before "real*8"

Modified Text:

DATA TYPE: array(1..2) of real*8

Software Requirements GCS Development Specification

Formal Modification # 2.2-7

Date: March 10, 1993

Part of Specification Affected:

Chapter 5

AECLP

Page 38, Section labeled "COMPUTE LIMITING ERRORS FOR PITCH"

Page 39, Section labeled "COMPUTE LIMITING ERRORS FOR YAW"

Page 39, Section labeled "COMPUTE LIMITING ERRORS FOR THRUST"

Reason for Modifications:

The variable GVE is a scalar, and thus references to it should not be subscripted.

Each of the variables PE_MIN, PE_MAX, TE_MIN, TE_MAX, YE_MIN, and YE_MAX is an array with two elements, and thus references to individual elements must be subscripted.

Modification:

Original Text:

COMPUTE LIMITING ERRORS FOR PITCH

- .. If $P_{\theta}^L < PE_MIN$ then set P_{θ}^L to PE_MIN .
- .. If $P_{\theta}^L > PE_MAX$ then set P_{θ}^L to PE_MAX .

COMPUTE LIMITING ERRORS FOR YAW

- .. If $Y_{\theta}^L < YE_MIN$ then set Y_{θ}^L to YE_MIN .
- .. If $Y_{\theta}^L > YE_MAX$ then set Y_{θ}^L to YE_MAX .

COMPUTE LIMITING ERRORS FOR THRUST

- $GVE(CL) \cdot VELOCITY_ERROR + GVEI(CL) \cdot TE_INTEGRAL$
- ... If $TE_LIMIT < TE_MIN$ then set TE_LIMIT to TE_MIN .
- ... If $TE_LIMIT > TE_MAX$ then set TE_LIMIT to TE_MAX .

Actions

- Replace occurrence of $GVE(CL)$ with GVE .
- Replace occurrences of PE_MIN , PE_MAX , TE_MIN , TE_MAX , YE_MIN , YE_MAX with $PE_MIN(CL)$, $PE_MAX(CL)$, $TE_MIN(CL)$, $TE_MAX(CL)$, $YE_MIN(CL)$, $YE_MAX(CL)$, respectively.

Modified Text:

COMPUTE LIMITING ERRORS FOR PITCH

- .. If $P_{\theta}^L < PE_MIN(CL)$ then set P_{θ}^L to $PE_MIN(CL)$.
- .. If $P_{\theta}^L > PE_MAX(CL)$ then set P_{θ}^L to $PE_MAX(CL)$.

COMPUTE LIMITING ERRORS FOR YAW

- .. If $Y_{\theta}^L < YE_MIN(CL)$ then set Y_{θ}^L to $YE_MIN(CL)$.
- .. If $Y_{\theta}^L > YE_MAX(CL)$ then set Y_{θ}^L to $YE_MAX(CL)$.

COMPUTE LIMITING ERRORS FOR THRUST

- $GVE_VELOCITY_ERROR + GVEI(CL) \cdot TE_INTEGRAL$
- .. If $TE_LIMIT < TE_MIN(CL)$ then set TE_LIMIT to $TE_MIN(CL)$.
- .. If $TE_LIMIT > TE_MAX(CL)$ then set TE_LIMIT to $TE_MAX(CL)$.

Software Requirements GCS Development Specification

Formal Modification # 2.2-8

Date: March 10, 1993

Part of Specification Affected:

Chapter 5

GP

Page 61, Section labeled "DETERMINE WHICH SET OF CONTROL LAW PARAMETERS TO USE"

Reason for Modifications:

The subset of variables listed in the first paragraph should not contain the variable GVE and is missing the variables PE_MIN, PE_MAX, TE_MIN, TE_MAX, YE_MIN, and YE_MAX.

Modification:

Original Text:

...This subset consists of the following eight variables: GVE, GVEI, GV, GVI, GR, GW, GWI, and GQ. Note that each one of these variables is an array of two elements. The eight elements with a subscript of one will be referred to as the "first" set of Control Law Parameters, while the eight elements with...

Actions

- Remove the variable GVE from the list
- Add the variables PE_MIN, PE_MAX, TE_MIN, TE_MAX, YE_MIN, and YE_MAX to the list.
- Remove all references to "eight" variables

Modified Text:

...This subset consists of the following variables: GVEI, GV, GVI, GR, GW, GWI, GQ, PE_MIN, PE_MAX, TE_MIN, TE_MAX, YE_MIN, and YE_MAX. Note that each one of these variables is an array of two elements. The elements with a subscript of one will be referred to as the "first" set of Control Law Parameters, while the elements with ...

Software Requirements GCS Development Specification

Formal Modification #2.2-9

Date: May 20, 1993

Part of Specification Affected:
INTRODUCTION

2.2-9

Location:

Page 13, section labeled DEFINITIONS, immediately before the definition for **Global Data Store Variable**".

Reason for Modification:

To define the use in this specification of the term "data store".

Action:

Insert definition for "data store"

New Text:

Data Store

The definition for a data or control store given in Hatley[13] is "A data or control store is simply a data or control flow frozen in time. The data or control information it contains may be used any time after that information is stored and in any order." In this specification, all stores contain data, while some also contain data conditions. For the purposes of this specification, the term "data store" will be used to refer to any store which contains some combination of data and data conditions. Thus, all four stores listed in the Data Requirements Dictionary part II will be referred to as "data stores".

Software Requirements GCS Development Specification

Formal Modification # 2.2-10

Date: May 27, 1993

Parts of Specification Affected:

Chapter 2, LEVEL 0 SPECIFICATION

Chapter 3, LEVEL 1 SPECIFICATION

2.2-10.1

Location:

Page 19

Reason for Modification:

In order to accurately reflect the new contents of Chapter 2.

Action:

Change the title.

Original Text

2. LEVEL 0 SPECIFICATION

Modified Text

2. LEVELS 0 and 1 SPECIFICATION

2.2-10.2

Location:

Page 21, second sentence

Reason for Modification:

To improve the wording.

Action:

Change the text "impact upon landing" to "touch down".

Original Text:

The purpose of the GCS is to keep the vehicle descending along the predetermined velocity-altitude contour which has been chosen to conserve enough fuel to effect a safe attitude and impact upon landing.

Modified Text:

The purpose of the GCS is to keep the vehicle descending along the predetermined velocity-altitude contour which has been chosen to conserve enough fuel to effect a safe attitude and touch down.

2.2-10.3

Location:

Page 21, last sentence in next-to-last paragraph.

Reason for Modification:

An explanation regarding the structured analysis diagrams has been added as the last paragraph in this section, and is not needed here.

Action:

Delete the entire sentence.

Original Text:

The figures in Chapters 2-4 follow the Structured Analysis/Structured Design notation (see Appendix A).

Modified Text:

(none)

2.2-10.4

Location

Page 21, immediately before last sentence in last paragraph

Reason for Modification:

A sentence was omitted.

Action:

Insert a new sentence "In addition, FORTRAN Intrinsic Functions may be used." between the two sentences in the original text.

Original Text:

"...in Appendix B. Other system services..."

Modified Text:

"...in Appendix B. In addition, FORTRAN Intrinsic Functions may be used. Other system services..."

2.2-10.5

Location:

Page 21, following last paragraph, and all of page 22.

Reason for Modification:

An explanation is required for the differences between the structured analysis diagrams in this specification and those in Hatley[13].

Action:

Insert new text after the last paragraph. Because the additional text does not all fit on page 21, the overflow has replaced page 22, and the new Figure 2.1 appears on page 23.

Original Text:

Other system services and library routines are explicitly excluded from use by the programmer.

Modified Text:

Other system services and library routines are explicitly excluded from use by the programmer.

Figures 2.2 through 2.5, 3.1, 3.2, and 4.1 through 4.4, and Tables 2.1, 3.1, 4.1, and 4.2 follow Hatley's extension to Structured Analysis (see Appendix A), with the following exceptions and assumptions.

Exceptions:

1. Any data store may appear at more than one level because the processes specified do not communicate directly but only through data stores.
2. Any unlabeled flow between a process and a data store may not necessarily carry all the information in the data store (the actual flow content is defined by the process specification and the Data Requirements Dictionary Part II).

Assumptions:

1. The initial value for control signals is assumed to be "FALSE".
2. In a process activation table (PAT), an empty process cell indicates the process is deactivated.
3. In a PAT, an empty output cell indicates the control signal value remains unchanged.
4. In a PAT, output control signals receive values before any processes are activated and therefore may delay the activation of processes by deactivating their parent process.

An example of assumption 4 is Table 3.1 where setting RENDEZVOUS to "TRUE" delays the activation of the processes of which RUN_GCS is composed until GCS_SIM sets RENDEZVOUS to "FALSE".

2.2-10.6

Location:

Page 23, entire page

Reason for Modification:

An additional figure showing the structure of the GCS specification is needed.

Action:

The old Figure 2.2 was replaced with an entirely new Figure 2.1.

2.2-10.7

Location:

Page 24, entire page

Reason for Modification:

The old structured analysis diagrams are being replaced by new ones.

Action:

A blank page was replaced with an entirely new structured analysis Figure 2.2.

2.2-10.8**Location:**

Page 25, entire page

Reason for Modification:

The old structured analysis diagrams are being replaced by new ones.

Action:

The old Chapter 3 title was replaced with an entirely new structured analysis Figure 2.3.

2.2-10.9**Location:**

Page 26, entire page

Reason for Modification:

The old structured analysis diagrams are being replaced by new ones.

Action:

A blank page was replaced with a Chapter 3 subtitle and an entirely new structured analysis Figure 2.4.

2.2-10.10**Location:**

Page 27

Reason for Modification:

The old structured analysis diagrams are being replaced by new ones.

Action:

The old Figure 3.1 and the chapter subtitle were replaced with an entirely new structured analysis Figure 2.5.

2.2-10.11**Location:**

Page 28

Reason for Modification:

The old structured analysis diagrams are being replaced by new ones.

Action:

The old Figure 3.2 and Table 3.1 were replaced with an entirely new structured analysis Table 2.1.

Software Requirements GCS Development Specification

Formal Modification # 2.2-11

Date: June 2, 1993

Parts of Specification Affected:

Chapter 4, LEVEL 2 SPECIFICATION

Modification 2.2-11.1

Location:

Page 29, chapter number

Reason for Modification:

The old Chapter 4 now becomes the new Chapter 3.

Action:

Change the chapter number.

Original Text

4. LEVEL 2 SPECIFICATION

Modified Text

3. LEVEL 2 SPECIFICATION

Modification 2.2-11.2

Location:

Page 31, section title on second line

Reason for Modification:

In order to reflect the new structured analysis diagrams.

Action:

Replace the section title.

Original Text:

PROCESS 1. INIT_GCS¹⁸

Modified Text:

PROCESS SPECIFICATION (P-Spec) 1: INIT_GCS¹⁸

Modification 2.2-11.3

Location:

Page 31, INPUT and OUTPUT sections

Reason for Modification:

The input is incorrect, and the output can be stated directly rather than using a reference to a table.

Action:

Replace both the INPUT and OUTPUT sections.

Original Text:

INPUT

None

OUTPUT

See Table 6.7

Modified Text:

INPUT

INITIALIZATION_DATA

OUTPUT

INITIALIZATION_DATA

Modification 2.2-11.4

Location:

Page 31, Subsection labeled "PROCESS", beginning with the first paragraph, last sentence, and continuing through to the end of the page.

Reason for Modification:

A new variable SUBFRAME_COUNTER is being added to the EXTERNAL data store for use by the functional unit CP. Also, the fact that FRAME_COUNTER and SUBFRAME_COUNTER are actually included in INITIALIZATION_DATA needs clarification.

Action:

Text has been reworded and reorganized to explain the initialization process and to specifically explain the initialization of the two variables FRAME_COUNTER and SUBFRAME_COUNTER.

Original Text:

The first call to GCS_SIM_RENDEZVOUS will cause INIT_GCS to automatically be executed, which will result in the loading of all necessary initial values and the initialization of the frame counter (FRAME_COUNTER) as follows:

LOAD INITIAL VALUES

- Load initial values for all variables listed in part III of the Data Requirements Dictionary, namely Table 6.7, *Initialization Data*.

SET FRAME COUNTER

- **FRAME_COUNTER** will be initialized to some number representing the next frame to be executed. This allows the option of starting execution at some point beyond the first frame of a trajectory.

Modified Text:

The first call to GCS_SIM_RENDEZVOUS will cause INIT_GCS to automatically be executed. INIT_GCS will initialize all variables in the group flow INITIALIZATION_DATA, which is defined in Table 6.7 in the Data Requirements Dictionary Part III. Since the variables FRAME_COUNTER and SUBFRAME_COUNTER are part of INITIALIZATION_DATA, they will be initialized at this time. FRAME_COUNTER will be initialized to a value representing the next frame to be executed, while SUBFRAME_COUNTER will always be initialized to the value one, which implies that the first subframe of the first frame to be executed will always be the sensor processing subframe. Although a terminal descent trajectory begins with FRAME_COUNTER initialized to the value one, the option exists for starting execution at some point other than at the beginning of the trajectory, i.e., FRAME_COUNTER may be initialized to a value greater than one.

Modification 2.2-11.5

Location:

Between pages 31 and 32

Reason for Modification:

Additional structured analysis figures and tables and one new chapter heading page were needed.

Action:

New pages 31.1 through and including page 31.9 have been added containing additional structured analysis diagrams (Figures 3.1, 3.2, 4.1, 4.2, 4.3, and Tables 3.1, 4.1) as well as one new chapter heading for Chapter 4 (page 31.4).

Modification 2.2-11.6

Location:

Page 32, entire page

Reason for Modification:

The old structured analysis diagrams are being replaced by new ones.

Action:

The old Figure 4.1 was replaced with an entirely new structured analysis Figure 4.4.

Modification 2.2-11.7

Location:

Page 33, entire page

Reason for Modification:

The old structured analysis diagrams are being replaced by new ones.

Action:

The old Figure 4.2 was replaced with an entirely new structured analysis Table 4.2.

Modification 2.2-11.8

Location:

Page 34, Section labeled "SCHEDULING", sixth sentence

Reason for Modification:

Clarification.

Action:

Add the text " (frame number 1)"

Original Text:

Also note that execution of the GCS may begin at any frame number and should operate as if it had been running from the beginning of the trajectory.

Modified Text:

Also note that execution of the GCS may begin at any frame number and should operate as if it had been running from the beginning of the trajectory (frame number 1).

Modification 2.2-11.9

Location:

Page 34, Section labeled "SCHEDULING", third sentence from end of paragraph.

Reason for Modification:

A new variable SUBFRAME_COUNTER is being added, and thus text describing the initialization and updating of the value of SUBFRAME_COUNTER needs to be included.

Action:

Add the text " and SUBFRAME_COUNTER".

Original Text:

On the first, and subsequent, calls to GCS_SIM_RENDEZVOUS, FRAME_COUNTER will be returned to the Implementation containing the correct value for operation.

Modified Text:

On the first, and subsequent, calls to GCS_SIM_RENDEZVOUS, FRAME_COUNTER and SUBFRAME_COUNTER will be returned to the Implementation containing the correct values for operation.

Modification 2.2-11.10

Location:

Page 34, Section labeled "SCHEDULING", second and next-to-last sentences

Reason for Modification:

Table 4.1 was renumbered to 4.3 because new tables were added before it.

Action:

Change the number of the table from 4.1 to 4.3.

Original Text:

"...Table 4.1..."

Action:

Change the number of the table.

Modified Text:

"...Table 4.3..."

Modification 2.2-11.11

Location:

Page 34, heading for table

Reason for Modification:

Table 4.1 was renumbered to 4.3 because new tables were added before it.

Action:

Change the number of the table.

Original Text:

Table 4.1: FUNCTIONAL UNIT SCHEDULING²¹

Modified Text:

Table 4.3: FUNCTIONAL UNIT SCHEDULING²¹

Modification 2.2-11.12

Location:

Page 34, footnote at bottom of page

Reason for Modification:

Chapter 5 now contains functional unit descriptions for both levels 3 and 4, rather than just level 3.

Action:

Delete reference to levels, and merely refer to the chapter.

Original Text:

"...In the Level 3 Specification, Chapter 5."

Modified Text:

"...In Chapter 5."

Modification 2.2-11.13

Location:

Between pages 34 and 35

Reasons for Modification:

The specification needs clarification regarding the requirement to execute sequential frames. Also, the criteria and procedures for terminating GCS had been given in the functional unit GP, but are more appropriate in the scheduling section.

Action:

Insert new page, namely page 34.1, with new text to describe the sequential execution of frames and also the reworded termination criteria and procedures for GCS.

New Text:

The GCS software must meet all the requirements for a particular frame for any specific value of the variable FRAME_COUNTER. The software must be capable of executing continuously one frame after another until specified termination conditions are met, at which time it must terminate itself according to specified termination procedures.

The termination conditions and procedures are: GCS should check whether to terminate itself in each frame immediately after executing the Guidance Processing functional unit. At that time if the value of the variable GP_PHASE is equal to 5, then GCS should terminate itself gracefully (without any exception conditions). In this case, the implementation should terminate at the end of the present subframe, i.e., it should execute the functional unit Communications Processing and then terminate without calling GCS_SIM_RENDEZVOUS.

Software Requirements GCS Development Specification

Formal Modification # 2.2-12

Date: June 2, 1993

Parts of Specification Affected

FOREWORD

Contents

List of Figures

List of Tables

Chapter 1, INTRODUCTION

Chapter 5, LEVEL 3 SPECIFICATION

General Reason for Modifications:

To bring the specification into agreement with the new structured analysis diagrams.

2.2-12.1

Location:

Page iii, second paragraph, sixth sentence

Reason for Modification:

The P-Specs for the functional units are now at both level 3 and level 4.

Action:

Change the reference.

Original Text:

"...(in level 3 of the specification)..."

Modified Text:

"...(in Chapter 5 of the specification)..."

2.2-12.2

Location:

Page vi

Reasons for Modifications:

The old structured analysis diagrams are being replaced by new ones in which an additional level was added to the structured diagrams, namely that for specifying the three subframes.

Actions:

The old Chapters 2 and 3 have now both been incorporated into Chapter 2 which now contains the specifications for levels 0 and 1 instead of just level 0.

The old Chapter 4 has become the new Chapter 3 which now contains the level 2 specification instead of the level 1 specification.

A new Chapter 4 has been included which now contains the level 3 flow diagrams and C-Specs instead of the level 2 specification.

The names for Chapters 2, 3, 4, and 5 were changed, and section headings were added for Chapters 2 and 3 and changed for Chapter 5.

The names for the section headings in Chapter 5 were changed.

Chapter 5 now contains the levels 3 and 4 P-Specs instead of just the level 3 specification.

The title for Chapter 6, Part III was changed in order to be a more accurate representation of the contents.

The title for Appendix A was changed to include the new level.

2.2-12.3

Location:

Page vii

The titles for Figures 2.1, 2.2, 3.1, 3.2, 4.1, and 4.2 were changed, and entries for Figures 2.3, 2.4, 2.5, 4.3, and 4.4 were added in order to incorporate the new structured analysis diagrams.

2.2-12.4

Location:

Page ix

The titles for Tables 3.1 and 4.1 were changed. Entries for Tables 2.1, 4.2, 4.3 and Tables 6.8 through 6.12 were added in order to incorporate the new structured analysis diagrams.

2.2-12.5

Location:

Page 12, Subsection labeled "Functional Unit", first sentence

Reason for Modification:

The P-Specs for the functional units are now at both levels 3 and level 4.

Action:

Change the reference.

Original Text

"Chapter 5 (LEVEL 3 SPECIFICATION) is divided..."

Modified Text

"Chapter 5 is divided..."

2.2-12.6

Location:

Page 14, Subsection labeled "Order of Processing", first sentence

Reason for Modification:

The P-Specs for the functional units are now at both levels 3 and level 4.

Action:

Change the reference.

Original Text

"...In the Level 3 specification,..."

Modified Text

"...In Chapter 5,..."

2.2-12.7

Location:

Page 15, Subsection labeled "Rotation of History Variables", first sentence.

Reason for Modification:

The P-Specs for the functional units are now at both levels 3 and level 4.

Action:

Change the reference.

Original Text

"In the LEVEL 3 SPECIFICATION,..."

Modified Text

"In Chapter 5,..."

2.2-12.8

Location:

Page 35

Reason for Modification:

The P-Specs for the functional units are now at both level 3 and level 4.

Action:

Replace the chapter title.

Original Text:

5. LEVEL 3 SPECIFICATION

Modified Text:

5. P-Specs FOR LEVELS 3 AND 4

Software Requirements GCS Development Specification

Formal Modification # 2.2-13

Date: June 2, 1993

Part of Specification Affected:

Chapter 5
AECLP

2.2-13.1

Location:

Page 37, title for P-Spec.

Reason for Modification:

In order to reflect the numbering in the new structured analysis charts.

Action:

Replace the title.

Original Text:

2.1 AECLP - Axial Engine Control Law Processing

Modified Text:

AECLP - Axial Engine Control Law Processing (P-Spec 2.3.1)

2.2-13.2

Location:

Page 37, INPUT (list of variables that are inputs to this functional unit)

Reasons for Modification:

The variables GP_ATTITUDE and GRAVITY were omitted from the list of inputs.

The variable AE_STATUS should not have been included in the list of inputs.

The input variables are not listed in ascii sequence.

Actions:

Add the variables GP_ATTITUDE and GRAVITY to the list of inputs.

Delete the variable AE_STATUS from the list of inputs.

Rearrange the modified list of inputs in ascii sequence.

Original Text:
INPUT

A_ACCELERATION	AE_STATUS
AE_SWITCH	AE_TEMP
CHUTE_RELEASED	CL
DELTA_T	FRAME_COUNTER
FRAME_ENGINES_IGNITED	FULL_UP_TIME
CONTOUR_CROSSED	ENGINES_ON_ALTITUDE
GA	GAX
GP_ALTITUDE	GP_ROTATION
GP_VELOCITY	GP1
GP2	GPY
GQ	GR
GV	GVE
GVEI	GVI
GW	GW1
OMEGA	PE_INTEGRAL
PE_MAX	PE_MIN
TE_INTEGRAL	TE_INIT
TE_LIMIT	TE_MAX
TE_MIN	TE_DROP
VELOCITY_ERROR	YE_INTEGRAL
YE_MAX	YE_MIN

Modified Text:
INPUT

AE_SWITCH	AE_TEMP
A_ACCELERATION	CHUTE_RELEASED
CL	CONTOUR_CROSSED
DELTA_T	ENGINES_ON_ALTITUDE
FRAME_COUNTER	FRAME_ENGINES_IGNITED
FULL_UP_TIME	GA
GAX	GP1
GP2	GPY
GP_ALTITUDE	GP_ATTITUDE
GP_ROTATION	GP_VELOCITY
GQ	GR
GRAVITY	GV
GVE	GVEI
GVI	GW
GW1	OMEGA
PE_INTEGRAL	PE_MAX
PE_MIN	TE_DROP
TE_INIT	TE_INTEGRAL
TE_LIMIT	TE_MAX
TE_MIN	VELOCITY_ERROR
YE_INTEGRAL	YE_MAX
YE_MIN	

Software Requirements GCS Development Specification

Formal Modification # 2.2-14

Date: June 2, 1993

Part of Specification Affected:

Chapter 5
GSP

2.2-14.1

Location:

Page 63, title for P-Spec.

Reason for Modification:

In order to reflect the numbering in the new structured analysis figures.

Action:

Replace the title.

Original Text:

2.7 GSP - Gyroscope Sensor Processing

Modified Text:

GSP - Gyroscope Sensor Processing (P-Spec 2.1.4)

2.2-14.2

Location:

Page 63, INPUT (list of variables that are inputs to this functional unit)

Reason for Modification:

The variable G_STATUS should not have been included in the list of inputs.

Action:

Delete the variable G_STATUS from the list of inputs.

Original Text:

INPUT

ATMOSPHERIC_TEMP	G3
G4	G_COUNTER
G_GAIN_0	G_OFFSET
G_ROTATION	G_STATUS

Modified Text:

INPUT

ATMOSPHERIC_TEMP	G3
G4	G_COUNTER
G_GAIN_0	G_OFFSET
G_ROTATION	

Software Requirements GCS Development Specification

Formal Modification # 2.2-15

Date: June 2, 1993

Part of Specification Affected:

Chapter 5
RECLP

2.2-15.1

Location:

Page 65 (with mod 2.2-2), title for P-Spec.

Reason for Modification:

In order to reflect the numbering in the new structured analysis figures.

Action:

Replace the title.

Original Text:

2.8 RECLP - Roll Engine Control Law Processing

Modified Text:

RECLP - Roll Engine Control Law Processing (P-Spec 2.3.2)

2.2-15.2

Location:

Page 65, INPUT (list of variables that are inputs to this functional unit)

Reason for Modification:

The variable RE_STATUS should not have been included in the list of inputs.

Action:

Delete the variable RE_STATUS from the list of inputs.

Original Text:

INPUT

DELTA_T	G_ROTATION
P1	P2
P3	P4
RE_STATUS	RE_SWITCH
THETA	THETA1
THETA2	

Modified Text:

INPUT

DELTA_T	G_ROTATION
P1	P2
P3	P4
RE_SWITCH	THETA
THETA1	THETA2

Software Requirements GCS Development Specification

Formal Modification # 2.2-16

Date: June 2, 1993

Part of Specification Affected:

Chapter 5
TDLRSP

2.2-16.1

Location:

Page 67, title for P-Spec.

Reason for 2.2-16.:

In order to reflect the numbering in the new structured analysis figures.

Action:

Replace the title.

Original Text:

2.9 TDLRSP - Touch Down Landing Radar Sensor Processing

Modified Text:

TDLRSP - Touch Down Landing Radar Sensor Processing (P-Spec 2.1.3)

2.2-16.2:

Location:

Page 67, INPUT (list of variables that are inputs to this functional unit)

Reason for 2.2-16.:

The variable TDLR_STATUS should not have included in the list of inputs.

Action:

Delete the variable TDLR_STATUS from the list of inputs.

Original Text:

INPUT

DELTA_T	FRAME_BEAM_UNLOCKED
FRAME_COUNTER	K_MATRIX
TDLR_ANGLES	TDLR_COUNTER
TDLR_GAIN	TDLR_LOCK_TIME
TDLR_OFFSET	TDLR_STATE
TDLR_STATUS	TDLR_VELOCITY

Modified Text:

INPUT

DELTA_T	FRAME_BEAM_UNLOCKED
FRAME_COUNTER	K_MATRIX
TDLR_ANGLES	TDLR_COUNTER
TDLR_GAIN	TDLR_LOCK_TIME
TDLR_OFFSET	TDLR_STATE
TDLR_VELOCITY	

Software Requirements GCS Development Specification

Formal Modification # 2.2-17

Date: June 3, 1993

Part of Specification Affected:

Chapter 5

TSP

2.2-17.1

Location:

Page 75, title for P-Spec.

Reason for Modification:

In order to reflect the numbering in the new structured analysis figures.

Action:

Replace the title.

Original Text:

2.11 TSP - Temperature Sensor Processing

Modified Text:

TSP - Temperature Sensor Processing (P-Spec 2.1.5)

2.2-17.2

Location:

Page 75, INPUT (list of variables that are inputs to this functional unit)

Reason for Modification:

The variable TS_STATUS should not have been included in the list of inputs.

Action:

Delete the variable TS_STATUS from the list of inputs.

Original Text:

INPUT

M1	M2
M3	M4
SS_TEMP	T1
T2	T3
T4	THERMO_TEMP
TS_STATUS	

Modified Text:

INPUT

M1	M2
M3	M4
SS_TEMP	T1
T2	T3
T4	THERMO_TEMP

Software Requirements GCS Development Specification

Formal Modification # 2.2-18

Date: June 3, 1993

Part of Specification Affected:

Chapter 5

ARSP, ASP, CRCP, and TDSP

2.2-18.1

Location:

ARSP, page 43 (with mod 2.2-5), title for P-Spec

Reason for Modification:

In order to reflect the numbering in the new structured analysis figures.

Action:

Replace the title.

Original Text:

2.2 ARSP - Altimeter Radar Sensor Processing

Modified Text:

ARSP - Altimeter Radar Sensor Processing (P-Spec 2.1.2)

2.2-18.2

Location:

ASP, page 45, title for P-Spec

Reason for Modification:

In order to reflect the numbering in the new structured analysis figures.

Action:

Replace the title.

Original Text:

2.3 ASP - Accelerometer Sensor Processing

Modified Text:

ASP - Accelerometer Sensor Processing (P-Spec 2.1.1)

2.2-18.3

Location:

CRCP, page 53, title for P-Spec

Reason for Modification:

In order to reflect the numbering in the new structured analysis figures.

Action:

Replace the title.

Original Text:

2.5 CRCP - Chute Release Control Processing

Modified Text:

CRCP - Chute Release Control Processing (P-Spec 2.3.3)

2.2-18.4

Location:

TDSP, page 73, title for P-Spec

Reason for Modification:

In order to reflect the numbering in the new structured analysis figures.

Action:

Replace the title.

Original Text:

2.10 TDSP - Touch Down Sensor Processing

Modified Text:

TDSP - Touch Down Sensor Processing (P-Spec 2.1.6)

Software Requirements GCS Development Specification

Formal Modification # 2.2-19

Date: June 3, 1993

Part of Specification Affected:
BIBLIOGRAPHY

2.2-19

Location:

Page 119, following reference [18]

Reason for Modification:

teamwork was used for developing structured analysis charts.

Action:

Add reference for *teamwork*

New Text:

[19] *teamwork/SA teamwork/RT User's Guide*, Cadre Technologies, Inc., Providence, Rhode Island, Release 4.0, 1990.

Software Requirements GCS Development Specification

Formal Modification # 2.2-20

Date: June 3, 1993

Part of Specification Affected:

Chapter 5
GP

2.2-20.1

Location:

Page 55, title for P-Spec.

Reason for Modification:

In order to reflect the numbering in the new structured analysis figures.

Action:

Replace the title.

Original Text:

2.6 GP - Guidance Processing

Modified Text:

GP - Guidance Processing (P-Spec 2.2)

2.2-20.2

Location:

Page 60, step labeled "PHASE 1."

Reason for Modification:

The phrase "**and the engines were not turned off in prior frame**" is unnecessary because when the lander is in Phase 1, the engines will not yet have been turned off.

Action:

Delete the text "**and the engines were not turned off in prior frame**"

Original Text:

PHASE 1: If the altitude provided by the guidance processor is less than or equal to the ENGINES_ON_ALTITUDE **and the engines were not turned off in prior frame**, set GP_PHASE = 2.⁴⁸

Modified Text:

PHASE 1: If the altitude provided by the guidance processor is less than or equal to the ENGINES_ON_ALTITUDE, set GP_PHASE = 2.⁴⁸

2.2-20.3

Location:

Page 61 (with mod 2.2-8), step labeled "PHASE 4", second paragraph.

Reasons for Modification:

The termination of GCS is not necessarily a requirement for the functional unit GP, but is actually a scheduling requirement; therefore, the conditions and procedures for termination of GCS would be more appropriate in the scheduling section. The text describing termination needs clarification. The control signal "END_GCS" is not used in the new structured analysis charts.

Action:

Delete the paragraph from the functional unit GP and include a modified version of it in the scheduling section (see Formal Modification 2.2-11.13).

Original Text:

It should be noted that under certain conditions, the next phase is **5 which means "END_GCS"**. This means that the implementation should stop itself at the end of the present subframe. Thus, in all cases, **a GCS implementation should stop** just after Communications Processing during the Guidance subframe, but before calling rendezvous.

Modified Text:

(none)

Software Requirements GCS Development Specification

Formal Modification # 2.2-21

Date: June 4, 1993

Parts of Specification Affected:

Chapter 5
CP

2.2-21.1

Location:

Page 49, title for P-Spec.

Reason for Modification:

In order to reflect the numbering in the new structured analysis diagrams.

Action:

Replace the title.

Original Text:

2.4 CP - Communications Processing

Modified Text:

CP - Communications Processing (P-Spec 2.4)

2.2-21.2

Location:

Page 49, INPUT, (list of variables that are inputs to this functional unit)

Reasons for Modification:

Some of the variables in the Data Store GUIDANCE_STATE are not inputs to this processing unit. The variable SUBFRAME_COUNTER should be included as an input. The variable C_STATUS should not be included as an input (see Formal Modification 2.2-21.9). The inputs are not listed in ascii sequence.

Actions:

The data store names GUIDANCE_STATE and SENSOR_OUTPUT have been replaced by the individual names of variables in those stores which are inputs to this functional unit. The variable SUBFRAME_COUNTER has been added to the input list. The variable C_STATUS has been deleted from the input list. The modified list of inputs has been arranged in ascii sequence.

Original Text:

INPUT

AE_CMD	C_STATUS
COMM_SYNC_PATTERN	FRAME_COUNTER
GUIDANCE_STATE	RE_CMD
SENSOR_OUTPUT	

Modified Text:

INPUT

AE_CMD	AE_STATUS
AE_TEMP	AR_ALTITUDE
AR_STATUS	ATMOSPHERIC_TEMP
A_ACCELERATION	A_STATUS
CHUTE_RELEASED	COMM_SYNC_PATTERN
CONTOUR_CROSSED	FRAME_COUNTER
GP_ALTITUDE	GP_ATTITUDE
GP_PHASE	GP_ROTATION
GP_VELOCITY	G_ROTATION
G_STATUS	K_ALT
K_MATRIX	PE_INTEGRAL
RE_CMD	RE_STATUS
SUBFRAME_COUNTER	TDLR_STATE
TDLR_STATUS	TDLR_VELOCITY
TDS_STATUS	TD_SENSED
TE_INTEGRAL	TS_STATUS
VELOCITY_ERROR	YE_INTEGRAL

2.2-21.3

Location:

Page 49, Subsection labeled "PROCESS", first sentence

Reason for Modification:

The order given for the items in the data packet does not agree with the correct order given in Table 5.7.

Action:

Move "checksum information" to the end of the list.

Original Text:

The data packet (PACKET) prepared for transmission is organized to sequentially contain a synchronization pattern, a sequence number, checksum information, new sample mask, and the data itself.

Modified Text:

The data packet (PACKET) prepared for transmission is organized to sequentially contain a synchronization pattern, a sequence number, new sample mask, the data itself, and the checksum information.

2.2-21.4

Location:

Page 49, Subsection labeled "DETERMINE SEQUENCE NUMBER", last sentence.

Reason for Modification:

The sentence was not explicit about the fact that the sequence number increases by one each subframe, and also the number 255 was incorrect.

Action:

Insert the phrase "increase by one every subframe, except that they" and change the text "255th" to "256th".

Original Text:

Sequence numbers repeat after the 255th packet, and can be calculated based on the FRAME_COUNTER and the subframe where the present call to CP was made.

Modified Text:

Sequence numbers increase by one every subframe, except that the values repeat after the 256th packet. The sequence number can be calculated based on the values of the variables FRAME_COUNTER and SUBFRAME_COUNTER.

2.2-21.5**Location:**

Page 49, Subsection labeled "PREPARE SAMPLE MASK", between second and third sentences.

Reason for Modification:

An explicit statement is needed regarding the functional units ARSP and TDLRSP.

Action:

Insert the text "The output variables from the functional units ARSP and TDLRSP, however, should not be transmitted when the variable FRAME_COUNTER is an even number."

Original Text:

"...mask and transmitted. Values that have been..."

Modified Text:

"...mask and transmitted. The output variables from the functional units ARSP and TDLRSP, however, should not be transmitted when the variable FRAME_COUNTER is an even number. Values that have been..."

2.2-21.6**Location:**

Pages 49-50, Subsection labeled "PREPARE SAMPLE MASK", the sentence which begins at the bottom of page 49 and continues at the top of page 50, and the second sentence on page 50.

Reason for Modification:

The first sentence is incorrect because some variables in GUIDANCE_STATE are never sent in the packet, and more clarity is needed in the second sentence regarding the correspondence between mask bits and variables to be sent.

Action:

Replace the two sentences.

Original Text:

A position should represent each variable contained in either GUIDANCE_STATE or SENSOR_OUTPUT in addition to AE_CMD and RE_CMD. These variables should be arranged as shown in table 5.5.

Modified Text:

Each bit position in the mask represents a particular variable listed in Table 5.5. The leftmost bit of the mask corresponds to AE_CMD, and moving across the mask from left to right, the next mask bit corresponds to the next variable in Table 5.5 (in row order).

2.2-21.7**Location:**

Page 50, Subsection labeled "PREPARE DATA SECTION, between the second and third sentences.

Reason for Modification:

The text needs some clarification regarding the exact manner in which the variables to be transmitted should be packed into the data section.

Action:

Insert clarifying text between the second and third sentences.

Original Text:

"...do not have to be transmitted. The data are concatenated..."

Modified Text:

"...do not have to be transmitted. Once it has been determined which variables should be transmitted for this particular subframe, those variables should be packed into the data section. Although the length of the variable PACKET is fixed, the number of bytes of PACKET which contain actual variables to be transmitted will vary depending on the values of FRAME_COUNTER and SUBFRAME_COUNTER. The variables to be transmitted should be concatenated so that there are no unused bytes between the data to be transmitted. There may however be unused bytes following the checksum. The data are concatenated..."

2.2-21.8

Location:

Page 50, Subsection labeled "CALCULATE CHECKSUM", following the last sentence in the section.

Reason for Modification:

The text needs some clarification regarding exactly where the checksum should be placed in the packet.

Action:

Insert clarifying text at the end of the paragraph.

New Text:

The checksum should be placed in the two bytes immediately following the last byte of actual data to be transmitted for this subframe.

2.2-21.9

Location:

Page 50, Subsection labeled "SET COMMUNICATOR STATUS TO HEALTHY".

Reason for Modification:

The variable C_STATUS should be set before preparing the data section, so that the value transmitted in the packet will be the new value set in this subframe rather than the value that was set in the previous subframe.

Action:

Move the entire Subsection "SET COMMUNICATOR STATUS TO HEALTHY" so that it is before the Subsection "CONSTRUCT PACKET".

Software Requirements GCS Development Specification

Formal Modification # 2.2-22

Date: June 4, 1993

Part of Specification Affected:
Appendix A

2.2-22.1

Location:

Page 105, title for the appendix.

Reason for Modification:

In order to reflect the new structured analysis diagrams.

Action:

Replace the title.

Original Text:

A. FORMAT DESCRIPTION FOR LEVEL 0, 1, 2 SPECIFICATIONS

Modified Text:

A. NOTATION FOR LEVELS 0, 1, 2, AND 3 SPECIFICATION

2.2-22.2

Location:

Page 107, title for the appendix.

Reason for Modification:

In order to reflect the new structured analysis diagrams.

Action:

Replace the title.

Original Text:

A. FORMAT DESCRIPTION FOR LEVEL 0, 1, 2 SPECIFICATIONS

Modified Text:

A. NOTATION FOR LEVELS 0, 1, 2, AND 3 SPECIFICATION

2.2-22.3

Location:

Page 107, first sentence.

Reason for Modification:

Reference to sources for development using structured analysis methods was not complete, and "." should be "," in reference.

Action:

Add a second reference, and change "." to ","

Original Text:

"...advocated by Hatley [12,13]."

Modified Text:

"...advocated by Hatley [12,13] and Cadre's teamwork [19]."

2.2-22.4

Location:

Page 107, entire third paragraph and first two sentences of the fourth paragraph.

Reason for Modification:

Inaccuracies.

Action:

Replace the third paragraph and the first sentence of the fourth paragraph.

Original Text:

The data flow diagrams describe the processes, data flows, data stores, and data conditions. The data context diagram is the highest-level data flow diagram and represents the data flow for the entire system. Data conditions are represented by directed arcs with broken lines.

The control flow diagrams describe processes, control signal flows, and stores. The control signal flows are depicted using directed arcs with broken lines.

Modified Text:

The data flow diagrams describe the processes, data flows, and data stores. The data context diagram is the highest-level data flow diagram and represents the data flow for the entire system.

The control flow diagrams describe processes, control signal and data condition flows, control specifications, and data stores. The control signal and data condition flows are depicted using directed arcs with broken lines.

2.2-22.5**Location:**

Page 107, fourth paragraph, next-to-last sentence.

Reason for Modification:

Statement is unclear and unnecessary.

Action:

Delete the entire sentence.

Original Text:

This duplication of processes is consistent with the approach of slaving the control flow to the data flow.

Modified Text:

(none)

2.2-22.6**Location:**

Page 107, last sentence

Reason for Modification:

To reflect new structured analysis diagrams.

Action:

Change phrase at end of sentence.

Original Text:

The Data Requirements Dictionary contains definitions for both data and control signals.

Modified Text:

The Data Requirements Dictionary contains definitions for data, data conditions, control signals, and group flows.

2.2-22.7**Location:**

Page 107, following the last sentence

Reason for Modification:

To reflect new structured analysis diagrams.

Action:

Add an additional paragraph to describe the meanings and definitions, etc. for the new structured analysis diagrams.

New Text:

Following is a list of definitions and explanations for the structured analysis diagrams:

1. The data and control flow names on the directed arcs in the structured analysis figures can be found in the Data Requirements Dictionary Part I, while the group flow names on the arcs can be found in the Data Requirements Dictionary Part III.
2. In the Process Activation Tables, the first column contains the inputs. The second set of columns (separated by two vertical lines) contains the cells which indicate whether a process is to be activated or deactivated. A blank cell indicates that the process is deactivated. An

integer indicates that the process is activated. A process whose cell contains the integer "n" must complete before the process with integer "n+1" is activated. All processes whose cells contain the same integer can be activated in any order. The third set of columns, if present, represents the output values for control signals.

3. The meanings for the symbols used in the expressions for inputs are:

=	equal
~=	not equal
~	logical NOT
&	logical AND
	logical OR
()	grouping (expression inside parentheses is evaluated first)

2.2-22.8

Location:

Page 108, graphical symbols

Reason for Modification:

To reflect the new structured analysis diagrams.

Action:

In the title, the word "FLOW" has been changed to "STRUCTURED ANALYSIS".

The rectangular symbol for PROCESS MODULE has been replaced with a bubble.

The dashed rectangular symbol for SOURCE OR SINK has been replaced with a solid rectangle.

The solid lines which represent a DATA STORE have been moved closer to each other.

Software Requirements GCS Development Specification

Formal Modification # 2.2-23

Date: June 4, 1993

Part of Specification Affected:

Chapter 6

PART I. DATA ELEMENT DESCRIPTIONS

2.2-23.1

Location:

Pages 83 through and including page 95 (with mod 2.2-6), all entries

Reason for Modification:

P-Spec numbers for functional units are unnecessary.

Action:

P-Spec numbers for functional units were deleted wherever they occurred.

2.2-23.2

Location:

Page 83, A_ACCELERATION, "USED IN" field

Reason for Modification:

Functional unit CP was omitted.

Action:

Functional unit CP was added.

Original Text:

NAME: A_ACCELERATION

USED IN: 2.1 AECLP, 2.3 ASP, 2.6 GP

Modified Text:

NAME: A_ACCELERATION

USED IN: AECLP, ASP, CP, GP

2.2-23.3

Location:

Page 83, AE_STATUS, "ATTRIBUTE" field

Reason for Modification:

Attribute is incorrect.

Action:

Attribute was changed from "data condition" to "data".

Original Text:

NAME: AE_STATUS

ATTRIBUTE: data condition

Modified Text:

NAME: AE_STATUS

ATTRIBUTE: data

2.2-23.4

Location:

Page 85, following entry for CL

Reason for Modification:

New structured analysis charts use new control signal, CLP_DONE.

Action:

New entry for CLP_DONE was added.

New Text:

NAME: CLP_DONE

DESCRIPTION: Control signal which indicates whether or not Control Law Processing function has completed.

USED IN: 2. RUN_GCS

UNITS: none

RANGE: [FALSE: running of Control Law Processing function incomplete;

TRUE: running of Control Law Processing function complete]

DATA TYPE: logical*1

ATTRIBUTE: control

DATA STORE LOCATION: none

ACCURACY: N/A

2.2-23.5**Location:**

Page 86, ENGINES_ON_ALTITUDE, "ATTRIBUTE" field

Reason for Modification:

Attribute is incorrect.

Action:

Attribute was changed from "data condition" to "data".

Original Text:

NAME: ENGINES_ON_ALTITUDE

ATTRIBUTE: data condition

Modified Text:

NAME: ENGINES_ON_ALTITUDE

ATTRIBUTE: data

2.2-23.6**Location:**

Page 86, FRAME_COUNTER, "USED IN" field

Reason for Modification:

Functional unit ARSP was omitted.

Action:

Functional unit ARSP was added.

Original Text:

NAME: FRAME_COUNTER

USED IN: 2.1 AECLP, 2.4 CP, 2.6 GP, 2.9 TDLRSP

Modified Text:

NAME: FRAME_COUNTER

USED IN: AECLP, ARSP, CP, GP, TDLRSP

2.2-23.7**Location:**

Page 86, FRAME_COUNTER, "ACCURACY" field

Reason for Modification:

This variable is not an output from GCS.

Action:

ACCURACY was changed from "TBD" to "N/A".

Original Text:

NAME: FRAME_COUNTER

ACCURACY: TBD

Modified Text:

NAME: FRAME_COUNTER

ACCURACY: N/A

2.2-23.8

Location:

Page 88, GP_ATTITUDE, "DESCRIPTION" field

Reason for Modification:

The description is inaccurate.

Action:

The description was replaced.

Original Text:

NAME: GP_ATTITUDE

DESCRIPTION: attitude as seen by guidance processor

Modified Text:

NAME: GP_ATTITUDE

DESCRIPTION: direction cosine matrix

2.2-23.9

Location:

Page 88, GP_ATTITUDE, "USED IN" field

Reason for Modification:

Functional unit AECLP was omitted.

Action:

Functional unit AECLP was added.

Original Text:

NAME: GP_ATTITUDE

USED IN: 2.4 CP, 2.6 GP

Modified Text:

NAME: GP_ATTITUDE

USED IN: AECLP, CP, GP

2.2-23.10

Location:

Page 88, GP_PHASE, "ATTRIBUTE" field

Reason for Modification:

The attribute should be "data condition"

Action:

The attribute was changed from "data" to "data condition".

Original Text:

NAME: GP_PHASE

ATTRIBUTE: data

Modified Text:

NAME: GP_PHASE

ATTRIBUTE: data condition

2.2-23.11

Location:

Page 88, GRAVITY, "USED IN" field

Reason for Modification:

Functional unit AECLP was omitted.

Action:

Functional unit AECLP was added.

Original Text:

NAME: GRAVITY

USED IN: 2.6 GP

Modified Text:

NAME: GRAVITY

USED IN: AECLP, GP

2.2-23.12**Location:**

Page 89, GSP_DONE, "UNITS" field

Reason for Modification:

Units are incorrect

Action:

Change units.

Original Text:

NAME: GSP_DONE

UNITS: Binary

Modified Text:

NAME: GSP_DONE

UNITS: none

2.2-23.13**Location:**

Page 89, GUIDANCE_STATE, entire entry

Reason for Modification:

The data stores are listed in Data Requirements Dictionary Part II.

Action:

The entire entry for GUIDANCE_STATE was deleted.

Original Text:

NAME: GUIDANCE_STATE

DESCRIPTION: Data store containing all the status, state, and sensed variables in alphabetical order.

USED IN: 2.1 AECLP, 2.2 ARSP, 2.3 ASP, 2.4 CP, 2.5 CRCP, 2.7 GSP, 2.6 GP, 2.8 RECLP, 2.9

TDLRSP, 2.10 TDSP, 2.11 TSP

UNITS: N/A

RANGE: N/A

DATA TYPE: common

ATTRIBUTE: data store

DATA STORE LOCATION: GUIDANCE_STATE

ACCURACY: N/A

Modified Text:

(no entry)

2.2-23.14**Location:**

Page 91 (with mod 2.2-6), RE_SWITCH, "USED IN" field

Reason for Modification:

Functional unit RECLP was omitted.

Action:

Functional unit RECLP was added.

Original Text:

NAME: RE_SWITCH

USED IN: 2.6 GP

Modified Text:

NAME: RE_SWITCH

USED IN: GP, RECLP

2.2-23.15**Location:**

Page 91 (with mod 2.2-6), following entry for RECLP_DONE

Reason for Modification:

New structured analysis charts use new control signal, RENDEZVOUS.

Action:

Add entry for RENDEZVOUS.

New Text:

NAME: RENDEZVOUS

DESCRIPTION: Control signal which indicates whether or not
GCS_SIM_RENDEZVOUS is to be activated.

USED IN: 2. RUN_GCS

UNITS: none

RANGE: [FALSE: GCS_SIM_RENDEZVOUS is not to be activated,
TRUE: GCS_SIM_RENDEZVOUS is to be activated]

DATA TYPE: logical*1

ATTRIBUTE: control

DATA STORE LOCATION: none

ACCURACY: N/A

2.2-23.16**Location:**

Page 92, RUN_PARAMETERS, entire entry

Reason for Modification:

The data stores are listed in Data Requirements Dictionary Part II.

Action:

The entire entry for RUN_PARAMETERS was deleted.

Original Text:

NAME: RUN_PARAMETERS

DESCRIPTION: Data store containing all the run
parameters in alphabetical order.

USED IN: 2.1 AECLP, 2.2 ARSP, 2.3 ASP, 2.4 CP,
2.6 GP, 2.7 GSP, 2.8 RECLP, 2.9 TDLRSP, 2.10
TDSP, 2.11 TSP

UNITS: N/A

RANGE: N/A

DATA TYPE: common

ATTRIBUTE: data store

DATA STORE LOCATION: RUN_PARAMETERS

ACCURACY: N/A

Modified Text:

(no entry)

2.2-23.17**Location:**

Page 92, SENSOR_OUTPUT, entire entry

Reason for Modification:

The data stores are listed in Data Requirements Dictionary Part II.

Action:

The entire entry for SENSOR_OUTPUT was deleted.

Original Text:

NAME: SENSOR_OUTPUT

DESCRIPTION: Data store containing all the sensor output in
alphabetical order.

USED IN: 2.1 AECLP, 2.2 ARSP, 2.3 ASP, 2.4 CP,
2.6 GP, 2.7 GSP, 2.8 RECLP, 2.9 TDLRSP, 2.10
TDSP, 2.11 TSP

UNITS: N/A

RANGE: N/A

DATA TYPE: common

ATTRIBUTE: data store

DATA STORE LOCATION: SENSOR_OUTPUT

ACCURACY: N/A

Modified Text:

(no entry)

2.2-23.18

Location:

Page 92, before entry for SS_TEMP

Reason for Modification:

New structured analysis charts use new control signal, SP_DONE.

Action:

Add entry for SP_DONE

New Text:

NAME: SP_DONE

DESCRIPTION: Control signal which indicates whether or not Sensor Processing function has completed.

USED IN: 2. RUN_GCS

UNITS: none

RANGE: [FALSE: running of Sensor Processing function incomplete;

TRUE: running of Sensor Processing function complete]

DATA TYPE: logical*1

ATTRIBUTE: control

DATA STORE LOCATION: none

ACCURACY: N/A

2.2-23.19

Location:

Page 92, following entry for SS_TEMP

Reason for Modification

New variable SUBFRAME_COUNTER is needed.

Action:

New entry for SUBFRAME_COUNTER was added.

New Text:

NAME: SUBFRAME_COUNTER

DESCRIPTION: Counter containing the number of the present subframe.

USED IN: CP

UNITS: none

RANGE: [1, 3]

DATA TYPE: Integer*2

ATTRIBUTE: data

DATA STORE LOCATION: EXTERNAL

ACCURACY: N/A

2.2-23.20

Location:

Page 93, TDLRSP_DONE, "RANGE" field

Reason for Modification:

"TDSP" is incorrect.

Action:

"TDSP" was replaced by "TDLRSP".

Original Text:

NAME: TDLRSP_DONE

RANGE: [0: running of task 2.11 TDLRSP incomplete, 1: running of task 2.10 TDSP complete]

Modified Text:

NAME: TDLRSP_DONE

RANGE: [0: running of task TDLRSP incomplete, 1: running of task TDLRSP complete]

2.2-23.21

Location:

Page 93, TDLRSP_SWITCH, entire entry

Reason for Modification:

The variable TDLRSP_SWITCH is not needed.

Action:

The entire entry for TDLRSP_SWITCH was deleted.

Original Text:

NAME: TDLRSP_SWITCH

DESCRIPTION: Flag indicating whether or not the touch down landing radar sensor processor is turned on.

USED IN: 1. INIT_GCS

UNITS: none

RANGE: [0: processor is off, 1: process is on.]

DATA TYPE: logical*1

ATTRIBUTE: data condition

DATA STORE LOCATION: GUIDANCE_STATE

ACCURACY: N/A

Modified Text:

(no entry)

2.2-23.22

Location:

Page 94, TDSP_SWITCH, entire entry

Reason for Modification:

The variable TDSP_SWITCH is not needed.

Action:

The entire entry for TDSP_SWITCH was deleted.

Original Text:

NAME: TDSP_SWITCH

DESCRIPTION: Flag indicating whether or not the touch down sensor is turned on.

USED IN: 0.GCS

UNITS: none

RANGE: [0: touch down sensor is off, 1: touch down sensor is on.]

DATA TYPE: logical*1

ATTRIBUTE: data condition

DATA STORE LOCATION: GUIDANCE_STATE

ACCURACY: N/A

Modified Text:

(no entry)

2.2-23.23

Location:

Page 94, TE_INTEGRAL, "USED IN" field

Reason for Modification:

Functional unit GP was omitted.

Action:

Functional unit GP was added.

Original Text:

NAME: TE_INTEGRAL

USED IN: 2.1 AECLP, 2.4 CP

Modified Text:

NAME: TE_INTEGRAL

USED IN: AECLP, CP, GP

2.2-23.24

Locations:

Page 83, AECLP_DONE, "RANGE" field
Page 84, ARSP_DONE, "RANGE" field
Page 84, ASP_DONE, "RANGE" field
Page 85, CP_DONE, "RANGE" field
Page 85, CRCP_DONE, "RANGE" field
Page 88, GP_DONE, "RANGE" field
Page 89, GSP_DONE, "RANGE" field
Page 89, INIT_DONE, "RANGE" field
Page 91, RECLP_DONE, "RANGE" field
Page 92, RUN_DONE, "RANGE" field
Page 93, TDLRSP_DONE, "RANGE" field
Page 94, TDSP_DONE, "RANGE" field
Page 95, TSP_DONE, "RANGE" field

Reason for Modification:

To reflect values used in new structured analysis diagrams

Action:

The value "0" was replaced by "FALSE", and the value "1" was replaced by "TRUE".

Original Text:

"RANGE: [0: " ... " incomplete, 1: " ... " complete]"

Modified Text:

"RANGE: [FALSE: " ... " incomplete, TRUE: " ... " complete]"

Software Requirements GCS Development Specification

Formal Modification # 2.2-24

Date: June 7, 1993

Part of Specification Affected:

Chapter 6

PART II. CONTENTS OF DATA STORES

2.2-24.1

Location:

Pages 97 through and including page 100, "USED BY" Column for all entries.

Reason for Modification:

P-Spec numbers for functional units are unnecessary.

Action:

P-Spec numbers for functional units were removed.

2.2-24.2

Location:

Page 97, Table 6.1, GP_ATTITUDE, "USED BY" Column

Reason for Modification:

Functional unit AECLP was omitted.

Action:

Functional unit AECLP was added.

Original Text:

GP_ATTITUDE 2.4 CP, 2.6 GP

Modified Text:

GP_ATTITUDE AECLP, CP, GP

2.2-24.3

Location:

Page 97, Table 6.1, RE_SWITCH, "USED BY" Column

Reason for Modification:

For consistency, INIT_GCS should not be included.

Action:

INIT_GCS was deleted.

Original Text:

RE_SWITCH INIT_GCS, 2.6 GP, 2.8 RECLP

Modified Text:

RE_SWITCH GP, RECLP

2.2-24.4

Location:

Page 97, Table 6.1, TDLR_STATE, "USED BY" Column

Reason for Modification:

Functional unit GP should not be included.

Action:

Functional unit GP was deleted.

Original Text:

TDLR_STATE 2.4 CP, 2.6 GP, 2.9 TDLRSP

Modified Text:

TDLR_STATE CP, TDLRSP

2.2-24.5

Location:

Page 97, Table 6.1, TDLRSP_SWITCH

Reason for Modification:

The variable TDLRSP_SWITCH is not needed.

Action:

Entire entry for TDLRSP_SWITCH was deleted.

Original Text:

TDLRSP_SWITCH INIT_GCS

Modified Text:

(no entry)

2.2-24.6

Location:

Page 97, Table 6.1, TDSP_SWITCH

Reason for Modification:

The variable TDSP_SWITCH is not needed.

Action:

Entire entry for TDSP_SWITCH was deleted.

Original Text:

TDSP_SWITCH 0.GCS

Modified Text:

(no entry)

2.2-24.7

Location:

Page 97, Table 6.1, TE_INTEGRAL, "USED BY" Column

Reason for Modification:

Functional unit GP was omitted.

Action:

Functional unit GP was added.

Original Text:

TE_INTEGRAL 2.1 AECLP, 2.4 CP

Modified Text:

TE_INTEGRAL AECLP, CP, GP

2.2-24.8

Location:

Page 98, Table 6.2, FRAME_COUNTER, "USED BY" Column

Reason for Modification:

Functional unit ARSP was omitted.

Action:

Functional unit ARSP was added.

Original Text:

FRAME_COUNTER 2.1 AECLP, 2.4 CP, 2.6 GP, 2.9 TDLRSP

Modified Text:

FRAME_COUNTER AECLP, ARSP, CP, GP, TDLRSP

2.2-24.9

Location:

Page 98, Table 6.2, between entries for SS_TEMP and TD_COUNTER

Reason for Modification:

New variable SUBFRAME_COUNTER is in the EXTERNAL data store.

Action:

SUBFRAME_COUNTER was added.

Original Text:	
SS_TEMP	2.11 TSP
TD_COUNTER	2.10 TDSP
Modified Text:	
SS_TEMP	TSP
SUBFRAME_COUNTER	CP
TD_COUNTER	TDSP

2.2-24.10

Location:

Page 99, Table 6.4, DELTA_T, "USED BY" Column

Reason for Modification:

Functional unit AECLP was omitted.

Action:

Functional unit AECLP was added.

Original Text:

DELTA_T	2.6 GP, 2.8 RECLP, 2.9 TDLRSP
---------	-------------------------------

Modified Text:

DELTA_T	AECLP, GP, RECLP, TDLRSP
---------	--------------------------

2.2-24.11

Location:

Page 99, Table 6.4, GRAVITY, "USED BY" Column

Reason for Modification:

Functional unit AECLP was omitted.

Action:

Functional unit AECLP was added.

Original Text:

GRAVITY	2.6 GP
---------	--------

Modified Text:

GRAVITY	AECLP, GP
---------	-----------

Software Requirements GCS Development Specification

Formal Modification # 2.2-25

Date: June 7, 1993

Part of Specification Affected:

Chapter 6

PART III. CONTROL VARIABLES, DATA CONDITIONS, AND INITIALIZATION DATA

2.2-25.1

Location:

Pages 101 through and including page 103, "USED BY" Column

Reason for Modification:

P-Spec numbers for functional units are unnecessary.

Action:

P-Spec numbers for functional units were removed.

2.2-25.2

Location:

Page 101, Part III title

Reason for Modification:

Title improvement

Action:

Replace title.

Original Text:

**PART III. CONTROL VARIABLES, DATA CONDITIONS, AND
INITIALIZATION DATA**

Modified Text:

PART III. CONTROL SIGNALS, DATA CONDITIONS, AND GROUP FLOWS.

2.2-25.3

Location:

Page 101, Table 6.5, title and contents

Reason for Modification:

Title improvement

The control variable INIT_DONE was omitted.

Three additional control variables, namely CLP_DONE, RENDEZVOUS, and SP_DONE are used in the new structured analysis diagrams.

Actions:

The title was changed.

The control variables INIT_DONE, CLP_DONE, RENDEZVOUS, and SP_DONE were added.

Original text:

Table 6.5: CONTROL VARIABLES (OPTIONAL USAGE)

CONTROL VARIABLE NAME
AECLP_DONE
ARSP_DONE
ASP_DONE
CP_DONE¹¹⁴
CRCP_DONE
GP_DONE
GSP_DONE
RECLP_DONE¹¹⁵
RUN_DONE¹¹⁶
TDLRSP_DONE
TDSP_DONE
TSP_DONE

Modified text:

Table 6.5: CONTROL SIGNALS (OPTIONAL USAGE)

CONTROL SIGNAL NAME
AECLP_DONE
ARSP_DONE
ASP_DONE
CLP_DONE
CP_DONE¹¹⁴
CRCP_DONE
GP_DONE
GSP_DONE
INIT_DONE
RECLP_DONE¹¹⁵
RENDEZVOUS
RUN_DONE¹¹⁶
SP_DONE
TDLRSP_DONE
TDSP_DONE
TSP_DONE

2.2-25.4

Location:

Page 101, Table 6.6, contents

Reason for Modification:

The variables AE_SWITCH, CONTOUR_CROSSED, RE_SWITCH and GP_PHASE were omitted.

Action:

The variables AE_SWITCH, CONTOUR_CROSSED, RE_SWITCH, and GP_PHASE were added.

Original text:

Table 6.6: DATA CONDITIONS (REQUIRED USAGE)

DATA CONDITION VARIABLE NAME
AE_TEMP
CHUTE_RELEASED
TD_SENSED
TDLR_STATE

Modified text:

Table 6.6: DATA CONDITIONS (REQUIRED USAGE)

DATA CONDITION VARIABLE NAME
AE_SWITCH
AE_TEMP
CHUTE_RELEASED
CONTOUR_CROSSED
GP_PHASE
RE_SWITCH
TD_SENSED
TDLR_STATE

2.2-25.5

Location:

Page 102, Table 6.7, DELTA_T, "USED BY" Column

Reason for Modification:

Functional units AECLP, RECLP, and TDLRSP were omitted.

Action:

Functional units AECLP, RECLP, and TDLRSP were added.

Original text:

DELTA_T 2.6 GP

Modified text:

DELTA_T AECLP, GP, RECLP, TDLRSP

2.2-25.6

Location:

Page 102, Table 6.7, FRAME_COUNTER, "USED BY" Column

Reason for Modification:

Functional unit ARSP was omitted.

Action:

Functional unit ARSP was added.

Original text:

FRAME_COUNTER 2.1 AECLP, 2.4 CP, 2.6 GP, 2.9 TDLRSP

Modified text:

FRAME_COUNTER AECLP, ARSP, CP, GP, TDLRSP

2.2-25.7

Location:

Page 102, Table 6.7, GP_ALTITUDE, "USED BY" Column

Reason for Modification:

Functional unit CP was omitted, and the order of units is incorrect.

Action:

Functional unit CP was added, and the order was corrected.

Original text:

GP_ALTITUDE 2.6 GP, 2.1 AECLP

Modified text:

GP_ALTITUDE AECLP, CP, GP

2.2-25.8**Location:**

Page 102, Table 6.7, GP_ATTITUDE, "USED BY" Column

Reason for Modification:

Functional units AECLP and CP were omitted.

Action:

Functional units AECLP and CP were added.

Original text:

GP_ATTITUDE 2.6 GP

Modified text:

GP_ATTITUDE AECLP, CP, GP

2.2-25.9**Location:**

Page 102, Table 6.7, GP_ROTATION, "USED BY" Column

Reason for Modification:

Functional units AECLP and CP were omitted, and RECLP should not have been included.

Action:

Functional units AECLP and CP were added, and RECLP was deleted.

Original text:

GP_ROTATION 2.6 GP, 2.8 RECLP

Modified text:

GP_ROTATION AECLP, CP, GP

2.2-25.10**Location:**

Page 102, Table 6.7, GP_VELOCITY, "USED BY" Column

Reason for Modification:

Functional units AECLP and CP were omitted.

Action:

Functional units AECLP and CP were added.

Original text:

GP_VELOCITY 2.6 GP

Modified text:

GP_VELOCITY AECLP, CP, GP

2.2-25.11**Location:**

Page 102, Table 6.7, GRAVITY, "USED BY" Column

Reason for Modification:

Functional unit AECLP was omitted.

Action:

Functional unit AECLP was added.

Original text:

GRAVITY 2.6 GP

Modified text:

GRAVITY AECLP, GP

2.2-25.12**Location:**

Page 103, Table 6.7, RE_SWITCH,"USED BY" Column

Reason for Modification:

INIT_GCS should not have been included.

Action:

INIT_GCS was deleted.

Original text:

RE_SWITCH	INIT_GCS, 2.6 GP, 2.8 RECLP
-----------	-----------------------------

Modified text:

RE_SWITCH	GP, RECLP
-----------	-----------

2.2-25.13**Location:**

Page 103, Table 6.7, between SS_TEMP and T1

Reason for Modification:

New variable SUBFRAME_COUNTER is initialized.

Action:

Variable SUBFRAME_COUNTER was added

Original text:

SS_TEMP	2.11 TSP
---------	----------

T1	2.11 TSP
----	----------

Modified text:

SS_TEMP	TSP
---------	-----

SUBFRAME_COUNTER	CP
------------------	----

T1	TSP
----	-----

2.2-25.14**Location:**

Page 103, Table 6.7, between T4 and TD_SENSED

Reason for Modification:

The variable TD_COUNTER was omitted from the table.

Action:

Variable TD_COUNTER was added.

Original text:

T4	2.11 TSP
----	----------

TD_SENSED	2.4 CP, 2.6 GP, 2.10 TDSP
-----------	---------------------------

Modified text:

T4	TSP
----	-----

TD_COUNTER	TDSP
------------	------

TD_SENSED	CP, GP, TDSP
-----------	--------------

2.2-25.15**Location:**

Page 103, Table 6.7, TDLR_COUNTER,"USED BY" Column

Reason for Modification:

Functional unit TDSP is incorrect.

Action:

Functional unit TDSP was replaced by TDLRSP.

Original text:

TDLR_COUNTER	2.10 TDSP
--------------	-----------

Modified text:

TDLR_COUNTER	TDLRSP
--------------	--------

2.2-25.16

Location:

Page 103, Table 6.7, TDLR_STATE,"USED BY" Column

Reason for Modification:

Functional unit GP should not have been included

Action:

Functional unit GP was deleted.

Original text:

TDLR_STATE 2.4 CP, 2.6 GP, 2.9 TDLRSP

Modified text:

TDLR_STATE CP, TDLRSP

2.2-25.17

Location:

Page 103, Table 6.7, TDLRSP_SWITCH

Reason for Modification:

The variable TDLRSP_SWITCH is not needed.

Action:

Entire entry for TDLRSP_SWITCH was deleted.

Original text:

TDLRSP_SWITCH INIT_GCS

Modified text:

(no entry)

2.2-25.18

Location:

Page 103, Table 6.7, TDSP_SWITCH

Reason for Modification:

The variable TDSP_SWITCH is not needed.

Action:

Entire entry for TDSP_SWITCH was deleted.

Original text:

TDSP_SWITCH 0.GCS

Modified text:

(no entry)

2.2-25.19

Location:

Page 103, Table 6.7,TE_INTEGRAL,"USED BY" Column

Reason for Modification:

The functional unit GP was omitted.

Action:

Functional unit GP was added.

Original text:

TE_INTEGRAL AECLP, 2.4 CP

Modified text:

TE_INTEGRAL AECLP, CP, GP

2.2-25.20

Location:

Page 104

Reason for Modification:

Additional group flows were used in the new structured analysis charts.

Action:

Add Tables 6.8, 6.9, 6.10, 6.11, and 6.12.

Table 6.8: TEMP_DATA

VARIABLE NAME
SS_TEMP
THERMO_TEMP

Table 6.9: SENSOR_DATA

VARIABLE NAME
A_COUNTER
AR_COUNTER
TDLR_COUNTER
G_COUNTER
TEMP_DATA
TD_COUNTER

Table 6.10: OUTPUT_DATA

VARIABLE NAME
AE_CMD
RE_CMD
PACKET

Table 6.11: OUTPUT_CONTROL

VARIABLE NAME
AE_SWITCH
RE_SWITCH
CHUTE_RELEASED

Table 6.12: FRAME_DATA

VARIABLE NAME
FRAME_COUNTER
SUBFRAME_COUNTER

Software Requirements GCS Development Specification

Formal Modification # 2.2-26

Date: June 7, 1993

Part of Specification Affected:
INTRODUCTION
EXCEPTION HANDLING

2.2-26

Location:

Page 16, paragraph labeled "UPPER OR LOWER LIMIT EXCEEDED"

Reason for Modification:

The fact that the RUN_PARAMETERS and EXTERNAL data stores need not be checked for limits was omitted. Also, the fact that it is not necessary for the functional unit CP to make any checks for limits was omitted.

Action:

Change text to include the additional information.

Original Text:

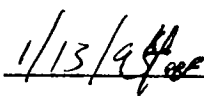
The current value for a data element exceeds its upper or lower limit as specified in the range section in the DATA DICTIONARY.

Modified Text:

The current value for a data element in the GUIDANCE_STATE or SENSOR_OUTPUT data store exceeds its upper or lower limit as specified in the range section in the Data Requirements Dictionary Part I. The data elements in the RUN_PARAMETERS and EXTERNAL data stores need not be checked for limit exceeded. In addition, it is not necessary for the functional unit CP to check any data elements for limit exceeded.

Support Documentation Change Report

page 1 of 3

1. Configuration Item Software Requirements GCS Development Specification Version 2.2	2. Date December 23, 1993	3. Formal Modification #: 2.2 - 27
4. Part of Configuration Item Affected: APPENDIX C. NUMERICAL INTEGRATION INSTRUCTIONS Page 118, immediately following the last paragraph. Table of Contents		
5. Reason for Modification: Clarification is needed in the adaptation of the Runge-Kutte fourth-order method to the GCS software for the Guidance Processing functional unit.		
6. Modification: Action: Add new text containing the clarification to the end of Appendix C. New Text: ADAPTATION OF RUNGE-KUTTE FOURTH-ORDER METHOD FOR SIMULTANEOUS EQUATIONS TO THE GCS SOFTWARE <p>In the case where the Runge-Kutte method has been selected for integration in the Guidance Processing functional unit, the following gives information on how it is to be applied to GCS. The notation and formulas presented here are merely one representation of the Runge-Kutte method and its adaptation to GCS. The software designer/implementer may vary the notation and/or the form of the equations as long as the algorithm used is equivalent to the one presented here.</p> <p>The Runge-Kutte fourth-order method (for one dependent variable only) can be summarized as follows: Given: Let $dy/dx = f(x,y)$ Let h represent the interval between equidistant values of x Let the initial values for x and y be x_0 and y_0 respectively Let $x_1 = x_0 + h$ The problem is to estimate y_1</p> <p>The solution is: $y_1 = y_0 + k$ $k = 1/6 \times (k_1 + 2 \times (k_2 + k_3) + k_4)$ where: $k_1 = h \times f(x_0, y_0)$ $k_2 = h \times f(x_0 + h/2, y_0 + k_1/2)$ $k_3 = h \times f(x_0 + h/2, y_0 + k_2/2)$ $k_4 = h \times f(x_0 + h, y_0 + k_3)$</p>		
7. SQA Signature & Date: Original Signed by George Finelli 1/13/94 		

Support Documentation Change Report Continuation

page 2 of 3

a. Report #: 2.2-27

b. Notes/Explanation (Please reference appropriate section number)

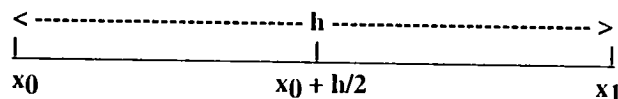
The GCS problem to be solved is as follows:

Simultaneously calculate current values for the variables GP_ATTITUDE, GP_VELOCITY, and GP_ALTITUDE, using the equations for the corresponding derivatives given in GUIDANCE PROCESSING (P-Spec 2.2), Table 5.8.

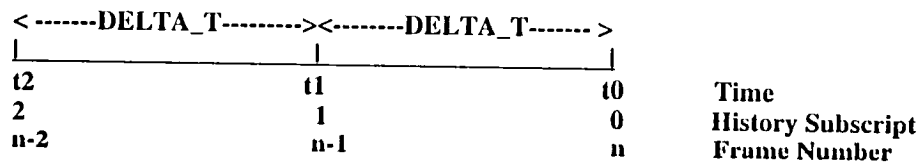
Adaptation to GCS of the Runge-Kutte fourth-order method for simultaneous equations

In the discussion that follows, let the "dependent" variables refer to GP_ATTITUDE, GP_VELOCITY, and GP_ALTITUDE, and let the "sensor" variables refer to G_ROTATION, A_ACCELERATION, K_MATRIX, TDLR_VELOCITY, K_ALT, and AR_ALTITUDE. In the Runge-Kutte method, it is assumed that the derivative for y can be obtained as a function of the dependent and independent variables. In GCS, the derivative for each of the dependent variables is a function of some subset of the dependent variables and some subset of the sensor variables. The values for the sensor variables are only available to GCS at discrete values of time, namely at any time which is an integer multiple of the value of DELTA_T. It is therefore not possible to calculate derivatives at the midpoint between two frames. The mapping of the Runge-Kutte independent variable to the GCS time interval is shown below. This mapping should be used, as it will ensure that derivatives can be calculated as required.

Runge-Kutte



GCS



where:

$$h = 2 \times \text{DELTA_T}$$

$t0$ = present time (time for the current frame)

$t1 = t0 - \text{DELTA_T}$ (time one frame ago)

$t2 = t0 - (2 \times \text{DELTA_T})$ (time two frames ago)

The Algorithm

The following is intended to be a conceptual representation of the Runge-Kutte algorithm as applied to GCS. It is not intended to be pseudocode or actual code. In this discussion, the subscripts for arrays have been omitted except for the history subscript which appears as "(j)" where j is 0, 1, or 2. This has been done here in order to present the concepts involved concisely, but without low-level details. The previously calculated values of the dependent variables at $t1$, although available, are not to be used. Also note that the history values of the dependent and sensor variables with subscripts of 3 and 4 are not used in this adaptation of Runge-Kutte to GCS.

Support Documentation Change Report Continuation

page 3 of 3

a. Report #: 2.2-27

b. Notes/Explanation (Please reference appropriate section number)

Notation

Let k_1, k_2, k_3, k_4 each represent a 3×3 array to hold estimate for change in attitude.

Let l_1, l_2, l_3, l_4 each represent a vector of size 3 to hold estimate for change in velocity.

Let m_1, m_2, m_3, m_4 each represent a scalar to hold estimate for change in altitude.

Let $\text{SENS_ATT}(j)$ represent the G_ROTATION array with time history subscript j , where j is 0, 1, or 2.

Let $\text{SENS_VEL}(j)$ represent the G_ROTATION , A_ACCELERATION , K_MATRIX , and TDLR_VELOCITY arrays with time history subscript (j), where $j = 0, 1$, or 2 .

Let $\text{SENS_ALT}(j)$ represent the K_ALT and AR_ALTITUDE arrays with time history subscript j , where $j = 0, 1$, or 2 .

Let f_{att} represent the function for derivative of attitude with respect to time.

Let f_{vel} represent the function for derivative of velocity with respect to time.

Let f_{alt} represent the function for derivative of altitude with respect to time.

Algorithm

Do first estimates of changes using derivatives calculated at t_2 :

$$k_1 = h \times f_{\text{att}}(\text{GP_ATTITUDE}(2), \text{SENS_ATT}(2))$$

$$l_1 = h \times f_{\text{vel}}(\text{GP_ATTITUDE}(2), \text{GP_VELOCITY}(2), \text{SENS_VEL}(2))$$

$$m_1 = h \times f_{\text{alt}}(\text{GP_ATTITUDE}(2), \text{GP_VELOCITY}(2), \text{GP_ALTITUDE}(2), \text{SENS_ALT}(2))$$

Do second estimates of changes using derivatives calculated at t_1 :

$$k_2 = h \times f_{\text{att}}(\text{GP_ATTITUDE}(2) + k_1/2, \text{SENS_ATT}(1))$$

$$l_2 = h \times f_{\text{vel}}(\text{GP_ATTITUDE}(2) + k_1/2, \text{GP_VELOCITY}(2) + l_1/2, \text{SENS_VEL}(1))$$

$$m_2 = h \times f_{\text{alt}}(\text{GP_ATTITUDE}(2) + k_1/2, \text{GP_VELOCITY}(2) + l_1/2, \text{GP_ALTITUDE}(2) + m_1/2, \text{SENS_ALT}(1))$$

Do third estimates of changes using derivatives calculated at t_1 :

$$k_3 = h \times f_{\text{att}}(\text{GP_ATTITUDE}(2) + k_2/2, \text{SENS_ATT}(1))$$

$$l_3 = h \times f_{\text{vel}}(\text{GP_ATTITUDE}(2) + k_2/2, \text{GP_VELOCITY}(2) + l_2/2, \text{SENS_VEL}(1))$$

$$m_3 = h \times f_{\text{alt}}(\text{GP_ATTITUDE}(2) + k_2/2, \text{GP_VELOCITY}(2) + l_2/2, \text{GP_ALTITUDE}(2) + m_2/2, \text{SENS_ALT}(1))$$

Do fourth estimates of changes using derivatives calculated at t_0 :

$$k_4 = h \times f_{\text{att}}(\text{GP_ATTITUDE}(2) + k_3, \text{SENS_ATT}(0))$$

$$l_4 = h \times f_{\text{vel}}(\text{GP_ATTITUDE}(2) + k_3, \text{GP_VELOCITY}(2) + l_3, \text{SENS_VEL}(0))$$

$$m_4 = h \times f_{\text{alt}}(\text{GP_ATTITUDE}(2) + k_3, \text{GP_VELOCITY}(2) + l_3, \text{GP_ALTITUDE}(2) + m_3, \text{SENS_ALT}(0))$$

Add weighted average of four change estimates to previous value of dependent variable to get current dependent variable:

$$\text{GP_ATTITUDE}(0) = \text{GP_ATTITUDE}(2) + 1/6 \times (k_1 + 2 \times (k_2 + k_3) + k_4)$$

$$\text{GP_VELOCITY}(0) = \text{GP_VELOCITY}(2) + 1/6 \times (l_1 + 2 \times (l_2 + l_3) + l_4)$$

$$\text{GP_ALTITUDE}(0) = \text{GP_ALTITUDE}(2) + 1/6 \times (m_1 + 2 \times (m_2 + m_3) + m_4)$$

Action: Change Table of Contents (page vii) to reflect change in page number for the Bibliography, from page 119 to page 123

Modified Text: BIBLIOGRAPHY 123

Support Documentation Change Report

page 1 of 2

1. Configuration Item Software Requirements GCS Development Specification Version 2.2	2. Date January 19, 1994	3. Formal Modification #: 2.2 - 28
4. Part of Configuration Item Affected: INTRODUCTION, Subsection Exception Conditions, UPPER OR LOWER LIMIT EXCEEDED Table of Contents		
5. Reason for Modification: In the requirements for checking for upper or lower limit exceeded, specificity is needed regarding the data types of the elements to be checked, the context in which the checks should be made, and when the checks should be performed.		
6. Modification: Action: Replace the entire paragraph under the heading "UPPER OR LOWER LIMIT EXCEEDED" with the new text. New Text: The current value for a data element exceeds its upper or lower limit as specified in the range section in the Data Requirements Dictionary Part I. Only certain data elements under certain conditions are to be checked for limits exceeded. The criteria for which elements are to be checked, in what context they are to be checked, and when they must be checked is as follows: Which data elements: A particular data element is to be checked for limits exceeded only if it is of data type REAL*8, and is in either of the two global data stores GUIDANCE_STATE or SENSOR_OUTPUT. Context for check: A data element is to be checked only when it is being used as an input. If the data element is a vector or array, then each element in the vector or array that is being used as input must be checked, including history values. It is not necessary for the functional unit CP to check any of its input data elements for limit exceeded. When data element must be checked: When an input data element is to be used or processed in a given subframe, then it must be checked sometime within that same subframe before it is used. If the data element is also being updated or changed in the same subframe before it is being used as an input, then it must be checked sometime between the time it is updated and the time it is used.		
7. SQA Signature & Date: Original Signed by <u>2/15/94</u> George Finelli		

Support Documentation Change Report Continuation

a. Report #: 2.2-28

b. Notes/Explanation (Please reference appropriate section number)

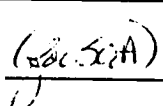
Action: Change Table of Contents (page vi) to reflect change in page number for the section Output to be Generated for Each Exception Condition, from page 16 to page 17

Modified Text:
Output to be Generated for Each Exception Condition 17

Support Documentation Change Report

1100

page 1 of 7

1. Configuration Item Software Requirements GCS Development Specification Version 2.2	2. Date March 15, 1994	3. Formal Modification #: 2.2 - 29
4. Part of Configuration Item Affected: Many miscellaneous parts are affected. (Each individual modification below lists the part affected by that modification)		
5. Reason for Modifications: Miscellaneous corrections, clarifications, and revisions (Each individual modification below lists the reason for that modification)		
6. Modifications Modification: 2.2-29.1: Part of Configuration Item Affected: Preface, first paragraph, last sentence Reason for Modification: Definition of "RTCA" has changed, and Guidelines DO-178B have replaced DO-178A Action: Change "Radio Technical Commission for Aeronautics RTCA/DO-178A " to "Requirements and Technical Concepts for Aviation RTCA/DO-178B" Modification: 2.2-29.2: Part of Configuration Item Affected: Preface, second paragraph, first and second sentences and last paragraph, second sentence Reason for Modification: Guidelines DO-178B have replaced DO-178A Action: Change "DO-178A" to "DO-178B" Modification: 2.2-29.3: Part of Configuration Item Affected: BIBLIOGRAPHY, item [1] Reason for Modification: Definition of "RTCA" has changed, and Guidelines DO-178B have replaced DO-178A Action: Replace the current item with the new text below: New Text: [1] Special Committee 167 of Requirements and Technical Concepts for Aviation Inc. (RTCA, Inc.). Software Considerations in Airborne Systems and Equipment Certification, DOCUMENT NO. RTCA/DO-178B. RTCA Inc., Washington, D. C., 1992.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst  3/16/94		

Report Continuation

page 2 of 7

a. Report #: Support Documentation Change Report 2.2-29

b. Notes/Explanation (Please reference appropriate section number)

Modification: 2.2-29.4:

Part of Configuration Item Affected: FOREWORD, first paragraph, second and third sentences

Reason for Modification: Redundant information (see Appendix A)

Action: Delete entire second sentence and change first two words of third sentence from "This specification" to "It"

Modification: 2.2-29.5:

Part of Configuration Item Affected: INTRODUCTION, second paragraph, third sentence

Reason for Modification: The roll engines are on at the beginning of the trajectory.

Action: Change "The axial and roll engines are ignited;" to "The axial engines are ignited;"

Modification: 2.2-29.6:

Part of Configuration Item Affected: INTRODUCTION, NOTATION, Matrices and Arrays, last sentence

Reason for Modification: Clarification needed

Action: Change the word "indices" to "index for the time history"

Modification: 2.2-29.7

Part of Configuration Item Affected: INTRODUCTION, REQUIREMENTS, Use of Tables , between second and third sentences

Reason for Modification: Clarification needed

Action: Insert a new sentence between these two sentences

New Text: If the actions in one line of the table are performed, then none of the actions in any other line of the table should be performed in the same subframe.

Modification: 2.2-29.8:

Part of Configuration Item Affected: AECLP, P-Spec 2.3.1, COMPUTE LIMITING ERRORS FOR PITCH

Reason for Modification: Clarification needed

Action: Replace the sentence "where t_0 is the beginning of the time step and t is the end of the time step." with the new text

New Text: where t_0 is the time at the beginning of this frame and t is the time at the end of this frame.

Modification: 2.2-29.9:

Part of Configuration Item Affected: AECLP, P-Spec 2.3.1, COMPUTE LIMITING ERRORS FOR YAW

Reason for Modification: Clarification needed

Action: Replace the sentence "where t_0 is the beginning of the time step and t is the end of the time step." with the new text

New Text: where t_0 is the time at the beginning of this frame and t is the time at the end of this frame.

Report Continuation

page 3 of 7

a. Report #: Support Documentation Change Report 2.2-29

b. Notes/Explanation (Please reference appropriate section number)

Modification: 2.2-29.10:

Part of Configuration Item Affected: AECLP, P-Spec 2.3.1, COMPUTE LIMITING ERRORS FOR THRUST, between the equation for TE_INTEGRAL and the sentence "Solve the following equation..."

Reason for Modification: Clarification needed

Action: Insert the new text

New Text: where t_0 is the time at the beginning of this frame and t is the time at the end of this frame.

Modification: 2.2-29.11:

Part of Configuration Item Affected: AECLP, P-Spec 2.3.1, Table 5.2

Reason for Modification: Clarification needed

Action: Insert the headings "CURRENT STATE" and "ACTIONS"

Modification: 2.2-29.12:

Part of Configuration Item Affected: AECLP, P-Spec 2.3.1, Table 5.3

Reason for Modification: Clarification needed

Action: Insert the headings "CURRENT STATE" and "ACTIONS"

Modification: 2.2-29.13:

Part of Configuration Item Affected: ASP, P-Spec 2.1.1, first paragraph, third sentence

Reason for Modification: The part of the sentence following the comma is not necessary, and is confusing.

Action: Delete the part of the sentence following the comma, and change the comma to a period. The new sentence is shown below:

New Text: The sign of the counter will always be positive, but the offset given in A_BIAS will be negative or zero.

Modification 2.2-29.14:

Part of Configuration Item Affected: GP, P-Spec 2.2, subsection labeled DETERMINE IF ENGINES SHOULD BE ON OR OFF, first sentence

Reason for Modification: FRAME_ENGINES_IGNITED could be initialized to some value other than zero if the initial FRAME_COUNTER is not initialized to the value one.

Action: Delete the words "to zero"

Modification 2.2-29.15:

Part of Configuration Item Affected: GP, P-Spec 2.2, Table 5.9

Reason for Modification: Clarification

Action: In the heading over the fourth column, change "a prior frame?" to "any prior frame?"

Report Continuation

page 4 of 7

a. Report #: Support Documentation Change Report 2.2-29

b. Notes/Explanation (Please reference appropriate section number)

Modification 2.2-29.16:

Part of Configuration Item Affected: GP, P-Spec 2.2, subsection labeled DETERMINE GUIDANCE PHASE, second paragraph, third sentence.

Reason for Modification: Inaccurate wording, and second double quote is in the wrong place

Action: Change "PRESENT STATE" DESCRIPTION to "CURRENT STATE DESCRIPTION"

Modification 2.2-29.17:

Part of Configuration Item Affected: GSP, P-Spec 2.1.4, subsection labeled PROCESS, table showing the map of G_COUNTER

Reason for Modification: Numbering of the bit positions is not consistent with numbering in the VAX FORTRAN Language Reference Manual.

Action: Change the numbering of the bits from 1 through 16 to 0 through 15.

Modification 2.2-29.18:

Part of Configuration Item Affected: RECLP, P-Spec 2.3.2, subsection labeled DETERMINE PULSE INTENSITY AND DIRECTION, sixth sentence

Reason for Modification: The word "step" has not been defined

Action: Change the word "step" to the word "frame"

Modification 2.2-29.19:

Part of Configuration Item Affected: RECLP, subsection labeled DETERMINE ROLL ENGINE COMMAND, table showing the layout of pulse intensity and direction in the roll engine command

Reason for Modification: The numbering of the bit positions is not consistent with the numbering in the VAX FORTRAN Language Reference Manual. In addition, the format of the table is not consistent with the table in GSP, P-Spec 2.1.4

Action: Change the numbering of the bits from 1 through 16 to 0 through 15, and move the bit positions to the top line and the layout to the bottom line.

Modification: 2.2-29.20:

Part of Configuration Item Affected: TDLRSP, P-Spec 2.1.3, Table 5.12

Reason for Modification: Clarification needed

Action: Insert the headings "CURRENT STATE" and "ACTIONS"

Modification: 2.2-29.21:

Part of Configuration Item Affected: DATA REQUIREMENTS, DICTIONARY, PART I, element COMM_SYNC_PATTERN, subsection RANGE

Reason for Modification: Clarification needed

Action: Add the text "(binary)"

___ Report Continuation

page 5 of 7

a. Report #: Support Documentation Change Report 2.2-29

b. Notes/Explanation (Please reference appropriate section number)

Modification: 2.2-29.22:

Part of Configuration Item Affected: DATA REQUIREMENTS DICTIONARY, PART I, element RE_SWITCH, subsection DATA STORE LOCATION

Reason for Modification: Typographical Error

Action: Change "GUIDANCE" to "GUIDANCE_STATE"

Modification: 2.2-29.23:

Part of Configuration Item Affected: DATA REQUIREMENTS DICTIONARY, PART I, element THETA, subsection DATA STORE LOCATION

Reason for Modification: Typographical Error

Action: Change "GUIDANCE" to "GUIDANCE_STATE"

Modification: 2.2-29.24:

Part of Configuration Item Affected: DATA REQUIREMENTS DICTIONARY, PART III, Table 6.6

Reason for Modification: Typographical Error

Action: Change "RE_SWTICH" to "RE_SWITCH"

Modification: 2.2-29.25:

Part of Configuration Item Affected: RECLP, P-Spec 2.3.2, Figure 5.2

Reason for Modification: Ambiguity

Action: Add the new text at the bottom of the figure.

New Text: Note: $P_1 < P_2 < P_3 < P_4$ and $\theta_1 < \theta_2$

Modification: 2.2-29.26:

Part of Configuration Item Affected: TSP, P-Spec 2.1.5, Figure 5.4

Reason for Modification: Ambiguity regarding M3, M4, T3, and T4, and also the parabolas need to be redrawn

Action: Add new text at the bottom of the figure concerning M3, M4, T3, and T4, and also redraw the parabolas

New Text: Note: $M_3 < M_4$ and $T_3 < T_4$

Modification: 2.2-29.27:

Part of Configuration Item Affected: APPENDIX C. NUMERICAL INTEGRATION INSTRUCTIONS, ADAPTATION OF RUNGE-KUTTE FOURTH-ORDER METHOD FOR SIMULTANEOUS EQUATIONS TO THE GCS SOFTWARE

Reason for Modification: Typographical errors

Action: Change the following terms (everywhere they appear):

from: $x_0, x_1, y_0, y_1, t_0, t_1, t_2, k_1, k_2, k_3, k_4, l_1, l_2, l_3, l_4, m_1, m_2, m_3, m_4$

to: $x_0, x_1, y_0, y_1, t_0, t_1, t_2, k_1, k_2, k_3, l_1, l_2, l_3, l_4, m_1, m_2, m_3, m_4$

respectively.

Report Continuation

page 6 of 7

a. Report #: Support Documentation Change Report 2.2-29

Modification: 2.2-29.28:

Part of Configuration Item Affected: Title Page

Reasons for Modification: Version number of document needs to be updated. The RTCA document number and the names of the authors were missing.

Actions: Change the version number of the document from 2.2 to 2.3. Add the RTCA Document number and the names of the authors.

Modification: 2.2-29.29:

Part of Configuration Item Affected: Page immediately following the title page

Reason for Modification: Acknowledgement page was missing

Action: Insert acknowledgement page after the title page

Modification: 2.2-29.30:

Part of Configuration Item Affected: Appendix B, INTERFACE, PROCESS section, first paragraph, last sentence, and GCS Initialization section, first sentence

Reasons for Modifications:

- The term "time step" has not been defined, and timing requirements have been removed
- The initial value for SUBFRAME_COUNTER was omitted

Actions:

- In the PROCESS section, change the text "time step" to "subframe", and delete the text "or have run out of time"
- In the GCS Initialization section, at the end of the first sentence, add the text ", and the subframe counter (SUBFRAME_COUNTER) will be initialized to the value one"

Modification: 2.2-29.31:

Part of Configuration Item Affected: INTRODUCTION, PURPOSE OF THE GUIDANCE AND CONTROL SOFTWARE, first sentence, and also the BIBLIOGRAPHY

Reason for Modifications: Reference to the Viking '75 Spacecraft paper was omitted

Actions: Insert a reference to the Viking paper in the INTRODUCTION, and insert an entry for the paper in the BIBLIOGRAPHY

Modification: 2.2-29.32:

Part of Configuration Item Affected: INTRODUCTION, GENERAL INFORMATION, NOTATION, Operators, Multiplication sign

Reason for Modifications: The terms i, j, and n are not defined

Actions: Define the range for i and j, and change the range for k.

Modification: 2.2-29.33:

Part of Configuration Item Affected: Chapter 5, ARSP (P-Spec 2.1.2), Table 5.4

Reason for Modifications: Heading in "Actions" columns is not consistent with other tables

Action: Change "ACTIONS TO BE TAKEN" to "ACTIONS"

Report Continuation

page 7 of 7

a. Report #: Support Documentation Change Report 2.2-29

Modification: 2.2-29.34:

Part of Configuration Item Affected: Chapter 5, CP (P-Spec 2.4), Table 5.5

Reason for Modifications: Since the table is to be read crosswise, the internal lines should be horizontal rather than vertical

Actions: Replace the internal vertical lines, with horizontal lines

Modification: 2.2-29.35:

Part of Configuration Item Affected: APPENDIX A, NOTATION FOR LEVELS 0, 1, AND 3 SPECIFICATION

Reason for Modifications: Clarification, more accurate wording, and additional text is needed

Actions:

- In the first paragraph, last sentence, change the text "functional modules" to "processes"
- In the second paragraph, first sentence, change the semicolons to commas, and change the word "descriptions" to "specifications"
- In the third paragraph, last sentence, change the text "for the entire system" to "between the system and the external entities"
- In the fourth paragraph, third sentence, change the text ";or," to ",or "
- In the fourth paragraph, replace the fourth sentence with the text "The flow diagrams show what the process structure must do under all conditions."
- In the fourth paragraph, next-to-last sentence, change the last word from "diagram" to "diagrams"
- In the fifth paragraph, last sentence, change the word "when" to "under which", and add the text ", and in some cases also contain output values for control signals" to the end of the sentence

Modification: 2.2-29.36:

Part of Configuration Item Affected: Entire specification

Reason for Modification: Version 2.2 is to be replaced by Version 2.3

Actions:

- Renumber the pages in the entire document
- Remove the notes "with mod 2.2-.." at the bottoms of the revised pages
- Remove the bolding and the footnote numbers that had previously been added as a result of changing from Version 2.1 to Version 2.2
- Remove the entire second paragraph of the FOREWORD, which expained the differences between Version 2.1 and Version 2.2 of this specification.
- Update the Table of Contents, List of Figures, and List of Tables to reflect the new page numbers

Support Documentation Change Report

page 1 of 1

1. Configuration Item Software Requirements GCS Development Specification Version 2.3	2. Date May 12, 1994	3. Formal Modification #: 2.3 - 1
4. Part of Configuration Item Affected: Miscellaneous parts are affected. (Each individual modification below lists the part affected by that modification)		
5. Reason for Modifications: Miscellaneous clarifications and revisions. (Each individual modification below lists the reason for that modification)		
6. Modifications Modification: 2.3-1.1: Part of Configuration Item Affected: Chapter 1, INTRODUCTION, REQUIREMENTS, Calls to GCS_SIM_RENDEZVOUS Reason for Modification: Clarification. Action: Add new text at the end of the sentence New Text: See Chapter 2 and Appendix B for discussions regarding GCS_SIM_RENDEZVOUS. Modification: 2.3-1.2: Part of Configuration Item Affected: Chapter 1, INTRODUCTION, REQUIREMENTS, EXCEPTION HANDLING, Output to be Generated for Each Exception Condition, <i>Lower Limit Exceeded</i> and <i>Upper Limit Exceeded</i> Reason for Modification: The only variables now being checked for limits exceeded are of type real. Action: Delete the text "for type real elements, and use FORMAT (x,a32,i12) for integer or logical data elements." Modification: 2.3-1.3: Part of Configuration Item Affected: Title Page Reason for Modification: Formal Modification Numbers are needed in addition to Version Number. Action: Add the Formal Modification Number 2.3-1 following the Version Number.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <div style="text-align: right;">5/13/94</div>		

Support Documentation Change Report

page 1 of 2

1. Configuration Item Software Requirements GCS Development Specification Version 2.3	2. Date May 18 1994	3. Formal Modification #: 2.3 - 2
4. Part of Configuration Item Affected: Miscellaneous parts are affected. (Each individual modification below lists the part affected by that modification)		
5. Reason for Modifications: The scheduling of the GCS functional units and the termination conditions are being modified.		
6. Modifications Modification: 2.3-2.1: Part of Configuration Item Affected: Chapter 4, SCHEDULING Reason for Modification: The scheduling of the functional units is being modified. The two major changes are that each functional unit will be executed every frame, and the check for termination will be made at the end of the third subframe instead of at the end of the second subframe. Action: Replace the entire section labeled SCHEDULING. Note: Even though this particular modification directly affects only the SCHEDULING section of Chapter 4, the changes made to this section do have an impact on the functional unit CP (P-Spec 2.4). This is due to the fact that each functional unit will now be scheduled every frame, and therefore the data which must be sent by CP in some subframes will be different from what it was when not every functional unit was being scheduled every frame. Modification: 2.3-2.2: Part of Configuration Item Affected: Chapter 5, ARSP -- Altimeter Radar Sensor Processing (P-Spec 2.1.2), Section labeled "PERFORM ALTERNATE PROCESSING IF THIS IS AN EVEN-NUMBERED FRAME" Reason for Modification: The actual calculations for this functional unit are to be performed each frame. Action: Delete the entire section.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 5/19/94		

Support Documentation Change Report Continuation

page 2 of 2

a. Report #: Support Documentation Change Report 2.3-2

b. Notes/Explanation (Please reference appropriate section number)

Modification: 2.3-2.3:

Part of Configuration Item Affected: Chapter 5, TDLRSP --Touch Down Landing Radar Sensor Processing (P-Spec 2.1.3), Section labeled "PERFORM ALTERNATE PROCESSING IF THIS IS AN EVEN-NUMBERED FRAME"

Reason for Modification: The actual calculations for this functional unit are to be performed each frame.

Action: Delete the entire section.

Modification: 2.3-2.4:

Part of Configuration Item Affected: Chapter 5, CP -- Communications Processing (P-Spec 2.4), section labeled PREPARE SAMPLE MASK, third sentence.

Reason for Modification: The scheduling changes in Formal Modifications 2.3-2.2, and 2.3-2.3 require that the calculations for functional units ARSP and TDLRSP be performed every frame, and since the outputs may change every frame, they should be sent every frame.

Action: Delete the third sentence which states "The output variables from the functional units ARSP and TDLRSP, however, should not be transmitted when the variable FRAME_COUNTER is an even number."

Modification: 2.3-2.5:

Part of Configuration Item Affected: Title Page

Reason for Modification: Formal Modification Numbers are needed in addition to Version Number.

Action: Add the Formal Modification Number 2.3-2 following the Version Number.

Support Documentation Change Report

page 1 of 2

1. Configuration Item Software Requirements GCS Development Specification Version 2.3	2. Date June 8, 1994	3. Formal Modification #: 2.3 - 3
4. Part of Configuration Item Affected: Several miscellaneous parts are affected. (Each individual modification below lists the part affected by that modification)		
5. Reasons for Modifications Miscellaneous corrections and clarifications. (Each individual modification below lists the reason for that modification)		
6. Modifications Modification: 2.3-3.1 Part of Configuration Item Affected: INTRODUCTION, EXCEPTION HANDLING, Exception Conditions, UPPER OR LOWER LIMIT EXCEEDED, Context for Check Reason for Modification: A clarification is required for the context in which a limit check should be made. Action: Insert new text between the first and second sentences. New Text: Rotation of a data element is not considered to be a use as an input for the purposes of limit checking. Modification: 2.3-3.2 Part of Configuration Item Affected: Chapter 5, AECLP, P-Spec 2.3.1, INPUT Table. Reason for Modification: Any variable which must be accessed in order to perform the functions of a functional unit should be listed in the INPUT Table for that functional unit, but the variable INTERNAL_CMD is not listed in the INPUT Table. Action: Add the variable INTERNAL_CMD to the INPUT Table. Modification: 2.3-3.3 Part of Configuration Item Affected: Chapter 5, ARSP, P-Spec 2.1.2, PROCESS section, first paragraph. Reason for Modification: This paragraph should have been deleted by Formal Modification 2.3-2, in which it was stated that this functional unit should be executed every frame. Action: Delete the entire paragraph.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <u>6/9/94</u>		

Support Documentation Change Report Continuation

page 2 of 2

a. Report #: Support Documentation Change Report 2.3-3

b. Notes/Explanation (Please reference appropriate section number)

Modification: 2.3-3.4

Part of Configuration Item Affected: Chapter 5, TDLRSP, P-Spec 2.1.3, PROCESS section, first paragraph.

Reason for Modification: This paragraph should have been deleted by Formal Modification 2.3-2, in which it was stated that this functional unit should be executed every frame.

Action: Delete the entire paragraph.

Modification: 2.3-3.5

Part of Configuration Item Affected: Chapter 5, CP, P-Spec 2.4, INPUT Table.

Reason for Modification: Any variable which must be accessed in order to perform the functions of a functional unit should be listed in the INPUT Table for that functional unit, but the variable C_STATUS is not listed in the INPUT Table.

Action: Add the variable C_STATUS to the INPUT Table.

Modification: 2.3-3.6

Part of Configuration Item Affected: Chapter 5, CP, P-Spec 2.4, PREPARE SAMPLE MASK, second and third sentences, and PREPARE DATA, second sentence.

Reason for Modification: In PREPARE SAMPLE MASK, an exception needs to be added to the second sentence, the third sentence needs more clarity, and the fourth sentence is unnecessary. In PREPARE DATA, the second sentence is redundant.

Action: In PREPARE SAMPLE MASK, replace the second and third sentences with the new text and delete the fourth sentence. In PREPARE DATA, delete the second sentence.

New Text: Any variables listed in Table 5.5 that may have changed during the present subframe should be marked in the mask and transmitted, with one exception. The variable TE_INTEGRAL may be changed by GP in the second subframe and by AECLP in the third subframe; however, TE_INTEGRAL should be transmitted by CP only during the third subframe, and not during the second subframe. In the case of any "history variable", that is, one which contains a time dimension, only the object (scalar, vector, or array) with a time subscript of zero should be transmitted.

Modification: 2.3-3.7

Part of Configuration Item Affected: Title Page

Reason for Modification: Formal Modification Numbers are needed in addition to Version Number.

Action: Add the Formal Modification Number 2.3-3 following the Version Number.

Support Documentation Change Report

page 1 of 2

1. Configuration Item Software Requirements GCS Development Specification Version 2.3	2. Date August 23, 1994	3. Formal Modification #: 2.3 - 4
4. Part of Configuration Item Affected: Miscellaneous parts are affected. (Each individual modification below lists the part affected by that modification)		
5. Reason for Modifications: Miscellaneous corrections and clarifications. (Each individual modification below lists the reason for the modification)		
6. Modifications Modification: 2.3-4.1 Part of Configuration Item Affected: TABLE OF CONTENTS and INTRODUCTION, REQUIREMENTS Reason for Modification: There is no explicit statement regarding the required precision for floating point calculations. Action: In the INTRODUCTION, add a subsection containing an explicit precision requirement for floating point calculations, and add this subsection name to the TABLE OF CONTENTS. Modification: 2.3-4.2 Part of Configuration Item Affected: Chapter 5, ASP (P-Spec 2.1.1), section labeled "DETERMINE ACCELERATIONS AND ACCELEROMETER STATUS" Reason for Modification: The form of the equation given for the standard deviation, if implemented exactly as shown, may result in a negative argument for the square root due to roundoff. Action: Change the form of the equation for the standard deviation to one which, if implemented exactly as shown, cannot lead to a negative argument for the square root. Modification: 2.3-4.3 Part of Configuration Item Affected: Chapter 6, PART I, DATA ELEMENT DESCRIPTIONS, element AE_TEMP Reason for Modification: AE_TEMP has three valid values, and thus a data type of integer*2 would be more appropriate than one of logical*1. Action: Change the data type of AE_TEMP from logical*1 to integer*2. Note: Even though this change is being made directly only to the Data Dictionary, it does have an impact on the packing of data for the third subframe into the PACKET array.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <div style="text-align: right; margin-right: 50px;"><u>8/24/94</u></div>		

Support Documentation Change Report Continuation

page 2 of 2

a. Report #: Support Documentation Change Report 2.3-4

b. Notes/Explanation (Please reference appropriate section number)

Modification: 2.3-4.4

Part of Configuration Item Affected: Chapter 6: PART I, DATA ELEMENT DESCRIPTIONS, element CHUTE_RELEASED; PART II, CONTENTS OF DATA STORES, Table 6.1 and Table 6.2

Reason for Modification: CHUTE_RELEASED is in the GUIDANCE_STATE store, but its value is transmitted to the external world, and thus it should be in the EXTERNAL store.

Action: In PART I, under CHUTE_RELEASED, change the DATA STORE LOCATION from GUIDANCE_STATE to EXTERNAL. In PART II, delete CHUTE_RELEASED from Table 6.1, and add CHUTE_RELEASED to Table 6.2.

Modification: 2.3-3.5

Part of Configuration Item Affected: Title Page

Reason for Modification: Formal Modification Numbers are needed in addition to Version Number.

Action: Add the Formal Modification Number 2.3-4 following the Version Number.

Support Documentation Change Report

page 1 of 4

1. Configuration Item Software Requirements GCS Development Specification Version 2.3	2. Date September 28, 1994	3. Formal Modification #: 2.3 - 5
4. Part of Configuration Item Affected: Miscellaneous parts are affected. (Each individual modification below lists the part affected by that modification)		
5. Reason for Modifications: Miscellaneous corrections and clarifications. (Each individual modification below lists the reason for the modification)		
6. Modifications Modification: 2.3-5.1 Part of Configuration Item Affected: INTRODUCTION, Figures 1.1, 1.2, and 1.3 Reason for Modification: The vehicle axes should form a right-handed coordinate system, but are not shown as such. Action: In Figure 1.1, change the direction of the positive Y axis. In Figure 1.2, change the direction of the positive Y and the positive Z axes, and enhance the phase descriptions. In Figure 1.3: in the "Bottom View", reverse the direction of the positive Y axis and of the positive roll; in the "Side View" on the left-hand bottom of the page, reverse the direction of the positive Y axis and of the positive yaw; in the "Side View" on the right-hand bottom of the page, change the note to show that the positive Y axis comes out of the page. Modification: 2.3-5.2 Part of Configuration Item Affected: Chapter 5, ARSP (P-Spec 2.1.2), input table. Reason for Modification: The variable FRAME_COUNTER is not an input to this functional unit. Action: Delete the variable FRAME_COUNTER from the input table. Modification: 2.3-5.3: Part of Configuration Item Affected: Chapter 5, ASP (P-Spec 2.1.1), input table Reason for Modification: The variables are not listed in ASCII order. Action: Arrange the variables in the input table in ascending ASCII sequence.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst		

9/23/94

Support Documentation Change Report Continuation

page 2 of 4

a. Report #: Support Documentation Change Report 2.3-5

b. Notes/Explanation (Please reference appropriate section number)

Modification: 2.3-5.4:

Part of Configuration Item Affected: Chapter 5, GP (P-Spec 2.2), input table

Reason for Modification: The variables are not listed in ASCII order.

Action: Arrange the variables in the input table in ascending ASCII sequence.

Modification: 2.3-5.5:

Part of Configuration Item Affected: Chapter 5, GP (P-Spec 2.2), section labeled "CALCULATE NEW VALUES OF ATTITUDE, VELOCITY, AND ALTITUDE", and Table 5.8

Reason for Modification: The equations for rate of change of attitude, velocity, and altitude need clarification.

Action: Replace Table 5.8 and most of the text in this section.

Modification: 2.3-5.6:

Part of Configuration Item Affected: Chapter 5, GP (P-Spec 2.2), section labeled "DETERMINE VELOCITY ERROR", and Figure 5.1.

Reason for Modification: Some of the wording in this section needs improvement, and in addition, it has not been made clear that the velocity being considered is the x component of the velocity.

Action: In the section DETERMINE VELOCITY ERROR, replace most of the text, and also add a statement concerning the minimum number of non-zero elements in CONTOUR_ALTITUDE. In Figure 5.1, change the label on the x-axis and on the trajectories, add a label for the constant-velocity part of the contour, and change the curves to make them distinguishable from each other.

Modification: 2.3-5.7:

Part of Configuration Item Affected: Chapter 5, GP (P-Spec 2.2), section heading "DETERMINE GUIDANCE PHASE"

Reason for Modification: All section headings should be in bold print.

Action: Change the heading to bold print.

Modification: 2.3-5.8:

Part of Configuration Item Affected: Chapter 5, GP (P-Spec 2.2), section labeled "DETERMINE WHICH SET OF CONTROL LAW PARAMETERS TO USE", second paragraph, seventh sentence, beginning with "The constant-velocity part of the contour..."

Reason for Modification: The explanation for the constant-velocity part of the contour needs clarification.

Action: Change the wording of this sentence.

Modification: 2.3-5.9:

Part of Configuration Item Affected: Chapter 5, GSP (P-Spec 2.1.4), section labeled "PURPOSE", first sentence.

Reason for Modification: The sentence states "as shown", but there is no figure.

Action: Delete the text "as shown".

Support Documentation Change Report Continuation

page 3 of 4

a. Report #: Support Documentation Change Report 2.3-5

b. Notes/Explanation (Please reference appropriate section number)

Modification: 2.3-5.10:

Part of Configuration Item Affected: Chapter 5, RECLP (P-Spec 2.3.2), FIGURE 5.2

Reason for Modification: There is no statement regarding the viewing reference for the roll thrust direction.

Action: Add a note at the bottom of Figure 5.2 regarding the viewing reference for the roll thrust direction.

Modification: 2.3-5.11

Part of Configuration Item Affected: Chapter 5, TDLRSP (P-Spec 2.1.3), section labeled "SET VALUES IN K_MATRIX"

Reason for Modification: Clarification is needed regarding the off-diagonal elements of K_MATRIX.

Action: Add a clarifying sentence as the last sentence in this section.

Modification: 2.3-5.12

Part of Configuration Item Affected: Chapter 5, TDSP (P-Spec 2.1.6), input and output tables

Reason for Modification: The variables are not listed in ASCII order.

Action: Arrange the variables in the input and output tables in ascending ASCII sequence.

Modification: 2.3-5.13

Part of Configuration Item Affected: Chapter 6, PART I, DATA ELEMENT DESCRIPTIONS, element ATMOSPHERIC_TEMP, section DATA STORE LOCATION.

Reason for Modification: "," does not belong at the end of the DATA STORE LOCATION.

Action: Remove the "," at the end of the DATA STORE LOCATION.

Modification: 2.3-5.14

Part of Configuration Item Affected: Chapter 6, PART I, DATA ELEMENT DESCRIPTIONS, element FRAME_ENGINES_IGNITED, section DATA STORE LOCATION.

Reason for Modification: The DATA STORE LOCATION is not correct.

Action: Change the DATA STORE LOCATION from GUIDANCE to GUIDANCE_STATE.

Modification: 2.3-5.15

Part of Configuration Item Affected: Chapter 6, PART I, DATA ELEMENT DESCRIPTIONS, element GP_ROTATION, section DATA STORE LOCATION.

Reason for Modification: "," does not belong at the end of the DATA STORE LOCATION.

Action: Remove the "," at the end of the DATA STORE LOCATION.

Modification: 2.3-5.16

Part of Configuration Item Affected: Chapter 6, PART I, DATA ELEMENT DESCRIPTIONS, element RE_CMD, section RANGE.

Reason for Modification: The values for the RANGE needs clarification.

Action: Replace the RANGE section.

___ Report Continuation

page 4 of 4

a. Report #: Support Documentation Change Report 2.3-5

b. Notes/Explanation (Please reference appropriate section number)

Modification: 2.3-5.17

Part of Configuration Item Affected: Chapter 6, PART I, DATA ELEMENT DESCRIPTIONS, element TE_LIMIT, ATTRIBUTE section.

Reason for Modification: Consistency of notation.

Action: Change "Data" to "data".

Modification: 2.3-5.18

Part of Configuration Item Affected: Title Page

Reason for Modification: Formal Modification Numbers are needed in addition to Version Number.

Action: Add the Formal Modification Number 2.3-5 following the Version Number.

Support Documentation Change Report

page 1 of 2

1. Configuration Item Software Requirements GCS Development Specification Version 2.3	2. Date December 21, 1994	3. Formal Modification #: 2.3 - 6
4. Part of Configuration Item Affected: Miscellaneous parts are affected. (Each individual modification below lists the part affected by that modification)		
5. Reason for Modifications: The Preface needs to be updated, and the calculation of the checksum in the communications functional unit needs additional requirements.		
6. Modifications Modification: 2.3-6.1 Part of Configuration Item Affected: TABLE OF CONTENTS Reason for Modification: A new appendix , namely Appendix D, is needed. Action: Add Appendix D to the TABLE OF CONTENTS. Modification: 2.3-6.2 Part of Configuration Item Affected: LIST OF TABLES Reason for Modification: TABLE 5.7 was renamed. Action: Change name of TABLE 5.7 in LIST OF TABLES. Modification: 2.3-6.3 Part of Configuration Item Affected: CP, Section labeled "PROCESS" Reason for Modification: The term "message" needs to be defined. Action: Replace the first sentence of this section. Modification: 2.3-6.4 Part of Configuration Item Affected: CP, Section labeled "CALCULATE CHECKSUM" Reason for Modification: Clarification is needed, and a reference is needed to point to the new Appendix D. Actions: Replace the first paragraph of this section, rename and replace TABLE 5.7 with a table that includes the byte allocations for each subframe, and delete the first part of the note under TABLE 5.7.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <div style="text-align: right;"><u>12/21/94</u></div>		

Support Documentation Change Report Continuation

page 2 of 2

a. Report #: Support Documentation Change Report 2.3-5

b. Notes/Explanation (Please reference appropriate section number)

Modification: 2.3-6.5

Part of Configuration Item Affected: Between Appendix C and the Bibliography.

Reason for Modification: Appendix D is needed.

Action: Add Appendix D.

Modification: 2.3-6.6

Part of Configuration Item Affected: Title Page

Reason for Modification: Formal Modification Numbers are needed in addition to Version Number, and line with "RTCA DO-178B Document Number 2" is not needed.

Action: Add the Formal Modification Number 2.3-6 following the Version Number, and delete the line "RTCA DO-178B Document Number 2".

Modification: 2.3-6.7

Part of Configuration Item Affected: Preface

Reason for Modification: The preface needs to be updated to be consistent with RTCA/DO-178B.

Action: Replace the entire preface.

Modification: 2.3-6.8

Part of Configuration Item Affected: Bibliography

Reason for Modification: The first two items in the bibliography are not consistent with the references in the new preface.

Action: Reverse the positions of the first two items in the bibliography.

Support Documentation Change Report

page 1 of 2

1. Configuration Item Software Requirements GCS Development Specification Version 2.2	2. Date March 14, 1995	3. Formal Modification #: 2.3-7
4. Part of Configuration Item Affected: Chapter 5, ASP (P-Spec 2.1.1); Chapter 5, GP (P-Spec 2.2); Title Page		
5. Reason for Modifications: Each individual modification below lists the reason for that modification		
6. Modifications Modification: 2.3-7.1: Part of Configuration Item Affected: Chapter 5, ASP (P-Spec 2.1.1), section labeled "DETERMINE ACCELERATIONS AND ACCELEROMETER STATUS" Reason for Modification: When all three previous values of A_STATUS are healthy and all three previous values of A_ACCELERATION are equal to each other, it is not necessary to check for extreme values of acceleration. Action: Under the sentence "the following steps are described for the x axis but should be performed for each axis:", a new condition was added as the second condition and the last condition was modified. Modification: 2.3-7.2: Part of Configuration Item Affected: Chapter 5, GP (P-Spec 2.2), Table 5.9 Reason for Modification: In the heading of the third column under "CURRENT STATE", eliminate the possibility of the argument of the square root function being negative, and eliminate any ambiguity from the fact that parentheses are not used. Action: Instead of using GP_ALTITUDE as the argument for the square root, the maximum of the two values, namely GP_ALTITUDE and zero, is to be used. Parentheses were also added. It was also necessary to add a footnote below the table because the new square root argument no longer fits in the table cell.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 3/15/95		

___ Report Continuation

page 2 of 2

a. Report #: Support Documentation Change Report 2.3-7

b. Notes/Explanation (Please reference appropriate section number)

Modification: 2.3-7.3:

Part of Configuration Item Affected: Chapter 5, GP (P-Spec 2.2), the section labeled "DETERMINE GUIDANCE PHASE", under "PHASE 3", and also Table 5.10.

Reason for Modification: In both places, eliminate the possibility of the argument of the square root function being negative.

Action: In Table 5.10 in the "EVENT" column, in the first line where the column GP_PHASE under "CURRENT STATE" contains "3" (fourth row of table), in order to avoid the possibility of the argument of the square root function being negative, the maximum of the two values, namely GP_ALTITUDE and zero, is to be used. It was necessary to add a footnote below the table because the square root argument would no longer fit in the table. It was also necessary to make the same change to the same expression under the bullet labeled "PHASE 3".

Modification: 2.3-7.4

Part of Configuration Item Affected: Title Page

Reason for Modification: Formal Modification Numbers are needed in addition to the Version Number, and the date needs to be updated.

Action: Add the Formal Modification Number 2.3-7 following the Version Number, and update the date.

Support Documentation Change Report

page 1 of 1

1. Configuration Item: Software Verification Cases	2. Date: 8/25/94	3. Formal Modification #: 1
4. Part of Configuration Item Affected: All AECLP Expected Values files (AECLP*.EX), The RUN_PARAMETERS namelist		
5. Reason for Modification: Creating new expected results files which will be able to compare all of the namelists, including the RUN_PARAMETERS.		
6. Modification: Creating new expected results files which will be able to compare all of the namelists, including the RUN_PARAMETERS.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 8/30/94		

Support Documentation Change Report

page 1 of 1

1. Configuration Item: Software Verification Cases	2. Date: 8/25/94	3. Formal Modification #: 2
4. Part of Configuration Item Affected: All CRCP Expected Values files (CRCP*.EX), The RUN_PARAMETERS namelist		
5. Reason for Modification: Creating new expected results files which will be able to compare all of the namelists, including the RUN_PARAMETERS.		
6. Modification: Creating new expected results files which will be able to compare all of the namelists, including the RUN_PARAMETERS.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <u>8/30/94</u>		

Support Documentation Change Report

page 1 of 1

1. Configuration Item: Software Verification Cases	2. Date: 9/7/94	3. Formal Modification #: 3
4. Part of Configuration Item Affected: All GP Testcases and Expected Values files		
5. Reason for Modification: The value for FRAME_ENGINES_IGNITED was set incorrectly in the input files.		
6. Modification: Put in the correct value for FRAME_ENGINES_IGNITED for all test cases, reran the <i>Mathematica</i> model and replaced all the test cases and expected results files associated with GP.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 9/15/94		

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1. Configuration Item: Software Verification Cases	2. Date: 9/19/94	3. Formal Modification #: 4
4. Part of Configuration Item Affected: All GP Testcases and Expected Values Files		
5. Reason for Modification: Due to Spec Mod 2.3-4.4 all test cases must be recreated in order to put CHUTE_RELEASED into the correct data store (EXTERNAL) and remove it from GUIDANCE_STATE.		
6. Modification: CHUTE_RELEASED was placed in the correct data store namelist in all test cases.		
7. SQA Signature & Date: Original Signed by <u>12/2/94</u> Kelly Hayhurst		

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1. Configuration Item: Software Verification Cases	2. Date: 9/19/94	3. Formal Modification #:5
4. Part of Configuration Item Affected: All AECLP Testcases and Expected Values files		
5. Reason for Modification: Due to Spec Mod 2.3-4.4 all test cases must be recreated in order to put CHUTE_RELEASED into the correct data store (EXTERNAL) and remove it from GUIDANCE_STATE.		
6. Modification: CHUTE_RELEASED was placed in the correct data store namelist in all testcases.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 12/2/94		

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1. Configuration Item: Software Verification Cases	2. Date: 9/19/94	3. Formal Modification #: 6
4. Part of Configuration Item Affected: All RECLP Testcases and Expected Values files		
5. Reason for Modification: Due to Spec Mod 2.3-4.4 all test cases must be recreated in order to put CHUTE_RELEASED into the correct data store (EXTERNAL) and remove it from GUIDANCE_STATE.		
6. Modification: CHUTE_RELEASED was placed in the correct data store namelist in all testcases.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 12/2/94		

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1. Configuration Item: Software Verification Cases	2. Date: 9/19/94	3. Formal Modification #: 7
4. Part of Configuration Item Affected: All CRCP Testcases and Expected Values files		
5. Reason for Modification: Due to Spec Mod 2.3-4.4 all test cases must be recreated in order to put CHUTE_RELEASED into the correct data store (EXTERNAL) and remove it from GUIDANCE_STATE.		
6. Modification: CHUTE_RELEASED was placed in the correct data store namelist in all testcases.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 12/2/94		

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1. Configuration Item: CP Test Cases	2. Date: 12- 21-94	3. Formal Modification #: 8
4. Part of Configuration Item Affected: Expected values files for CP test cases and CP model.		
5. Reason for Modification: The Packet processing for CP has been updated in the GCS Specification. The CP model must now be updated to match the Spec. The expected results must also be regenerated using the updated model.		
6. Modification: The model of CP has been updated so that the bit checksum bytes do not switch positions before being stored into the packet. The expected values files have been regenerated using the updated model.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <u>12/27/94</u>		

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1. Configuration Item: ASP Test Cases	2. Date: 12-28-94	3. Formal Modification #: 9
4. Part of Configuration Item Affected: ASP test cases and expected values files.		
5. Reason for Modification: The ASP Requirements based test cases test the wrong status variable. This directly effects 6 ASP test cases but should be corrected in all ASP test cases.		
6. Modification: All ASP test cases have been corrected to test the A_STATUS variable instead of AR_STATUS variable. The updated test cases have been re-executed with the VENUS prototype and no ".ANA" files were generated indicating that all expected values files match the prototype results.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst		

12/29/94

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1. Configuration Item: CP Model & CP Test Cases Expected Values Files	2. Date: 1-9-95	3. Formal Modification #: 10
4. Part of Configuration Item Affected: Expected values files for CP test cases and CP model.		
5. Reason for Modification: An error has been found in the CP test case expected values files. This error can be traced to modifications for SDCR-8 during which the CP model was modified and verified against the VENUS prototype. During that verification, necessary VENUS switches were not set causing no CRC checksum to be generated. The checksum needs to be added back to the PACKET variable in the expected values files		
6. Modification: The model of CP has been updated so that the bit checksum bytes are being stored into the packet. The expected values files have been regenerated using the updated model.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <u>1/12/95</u>		

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1. Configuration Item:

Verification Cases - Test Drivers

2. Date:

2-6-95

3. Formal Modification #:

11

4. Part of Configuration Item Affected:

Subframe and frame test drivers calculate the expected value of the PACKET data element. The subroutine that performs this calculation is P_EX_CP.FOR for the Pluto and Mercury implementation respectively.

5. Reason for Modification:

The subroutine for generating expected values for subframe and frame test cases use a duplicate of the CP model. This part was not updated when the Specification for CP was updated in formal mod # 2.3-6. The subroutines need to be modified so that the bit checksum is no longer flipped.

6. Modification:

In the file P_EX_CP.FOR the three instances of code which reverses the CRC byte has been commented out. The CRC byte is no longer flipped for any subframe packet.

*File should now be implemented
for Pluto and Mercury to comply.
H*

7. SQA Signature & Date:

Original Signed by
Kelly Hayhurst

2/8/95

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1. Configuration Item: Verification Cases - Subframe Test Cases	2. Date: 2-7-95	3. Formal Modification #: 12
4. Part of Configuration Item Affected: GPSF_001 to 008.TC, GPSF_001 to 008.EX, and CLP_011.TC, and CLP_011.EX		
5. Reason for Modification: The subframe counter value in the above test cases does not agree with the subframe being tested. This effects the generation of values for the PACKET data element during CP processing at the end of the subframe.		
6. Modification: The test case input and expected values files were edited instead of regenerated because only one item was changed and no calculations were involved. The subframe counter has been updated to 3 in the CLP_011.TC. The CLP_011.EX had the correct value for subframe counter so no editing was required. The subframe counter has been set to 2 for GP subframe test cases GPSF_001 to 008.TC and GPSF_001 to 008.EX.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <u>2/10/95</u>		

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2/11/95 *kg*

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1. Configuration Item: Verification Cases (Frame and Subframe Command files)	2. Date: 2/8/95	3. Formal Modification #: 13
4. Part of Configuration Item Affected: Frame and Subframe Command file		
5. Reason for Modification: The command files were not set up properly to run the frame and subframe test cases for Mercury.		
6. Modification: The following new command files were created: M_SP_DRIVER.COM, M_GPSF_DRIVER.COM, M_CLP_DRIVER.COM, M_LNKGPSF.COM, M_LNKFRAME_COM and M_LNKSP.COM. Path information was corrected from [cquach.gcs.test_cases.xx] to [dbt.test_cases.xx] Link command files were changed to reflect the differences between the Pluto and Mercury FORTRAN files.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst		

2/14/95

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1. Configuration Item: Verification Cases - Frame Test Cases	2. Date: 2-15-95	3. Formal Modification #: 14
4. Part of Configuration Item Affected: FRAME_001-009.TC and FRAME_001-009.EX. Also affected are test drivers for each implementations. These are P_TEST_FRAME.FOR and M_TEST_FRAME.FOR		
5. Reason for Modification: Local variable names in the frame model were miss-matched for GP_ALTITUDE. This caused the expected value of the GP_ALTITUDE history index to be incorrect.		
6. Modification: Test case FRAME001 to FRAME_008 were regenerated with the model of GP fetched from CMS. No changes were made to the GP model. The drivers were corrected so that the functional units are not called when GP_PHASE is 5.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <u>2/16/95</u>		

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1. Configuration Item: Verification Cases - Models	2. Date: 2-23-95	3. Formal Modification #: 15
4. Part of Configuration Item Affected: The model for generating expected values for GP test cases and all test cases that use the model. This includes the test GP functional unit test cases, the GP subframe test cases, the Frame test cases.		
5. Reason for Modification: The model for GP test cases does not transition from phase 4 to phase 5 correctly for when TDS_STATUS is FAILED and TD_SENSED is TOUCH_DOWN_NOT_SENSED.		
6. Modification: The model for GP has been corrected by removing the extra conditions in the statements the perform the GP_PHASE transition. All the GP related test cases have been regenerated.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <u>3/24/95</u>		

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1. Configuration Item: Verification Cases - Models	2. Date: 2-24-95	3. Formal Modification #: 16
4. Part of Configuration Item Affected: The GP strucutral test cases for Mercury, the expected values and the mathematica driver files .		
5. Reason for Modification: The model for GP test cases did not transition from phase 4 to phase 5 correctly for when TDS_STATUS is FAILED and TD_SENSED is TOUCH_DOWN_NOT_SENSED -- and was corrected as per SDCR #15. The corresponding corrections need to be made for the Mercury structural test cases. The driver files need to be replaced to reflect changes in names of the mathematica files.		
6. Modification: The test cases and expected values were recreated due to a change in the mathematica code (see SDCR 15). The driver files changed the actual code name of GP.TC.CODE to GP.M to reflect the names of the code saved in CMS.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <u>2/24/95</u>		

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Configuration Item: Verification Cases -Mathematica Drivers	2. Date: 2-24-95	3. Formal Modification #: 17
4. Part of Configuration Item Affected: The Mathematica drivers for the structural test cases for AECLP and RECLP (M_RUN_AECLP_ST.*, M_RUN_RECLP_ST.*)		
5. Reason for Modification: The driver files need to be replaced to reflect changes in names of the mathematica files.		
6. Modification: The driver files changed the actual code name of AECLP.TC.CODE to AECLP.M and RECLP.TC.CODE to RECLP.M to reflect the names of the code saved in CMS.		
SQA Signature & Date: Original Signed by Kelly Hayhurst 2/24/95		

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1. Configuration Item: Verification Cases (Frame and Subframe Command files)	2. Date: 2/25/95	3. Formal Modification #: 18
4. Part of Configuration Item Affected: GP Functional unit Test Cases, GP Subframe Test cases, GP Structural Test Cases, NAMELIST_EX		
5. Reason for Modification: When these files were recreated (SDCR 15) an old version of the namelist code was used. This code causes a problem when the values of G_ROTATION are negative. This only affects a few test cases, but all test cases should be recreated and rerun. In a FORTRAN namelist file anything in the 1st column is ignored.		
6. Modification: The modification was made to the file NAMELIST_EX which creates the expected values files. Spaces were added before the data was written to the file. The test cases were then rerun.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <u>2/27/95</u>		

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1. Configuration Item: Verification Cases	2. Date: 3/1/95	3. Formal Modification #: 19
4. Part of Configuration Item Affected: Structural test cases for GP for the Mercury implementation		
5. Reason for Modification: The structural test cases for GP should have been reserved and changed under SDCR 18; however, due to an oversight, those test cases were not reserved. Those test cases still need to be modified as described in SDCR 18.		
6. Modification: The modification was made to the NAMELIST_EX which creates the expected value files. Spaces were added before the data was written to the file.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst - 3/1/95		

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1. Configuration Item: Verification Cases	2. Date: 3/1/95	3. Formal Modification #: 20
4. Part of Configuration Item Affected: The GP subframe expected values files and the GP subframe mathematica run files.		
5. Reason for Modification: The changes made in SDCR 18 were implemented incorrectly due to an error in the run files. The expected values data did not have the prefix EX_ in front of the variable names.		
6. Modification: Modification was made in the RUN_GSF.xx files replacing the last call to NAMELIST1 with NAMELIST_EX.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst		

3/2/95

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1. Configuration Item: Verification Cases	2. Date: 3-1-95	3. Formal Modification #: 21
4. Part of Configuration Item Affected: GP_PST_001-021.TC & EX		
5. Reason for Modification: The model for GP test cases has been updated and these test cases need to be regenerated using the new model. (related to SDCR #15 : 15 changed the model, this SDCR is to change the actual test cases)		
6. Modification: All 21 Pluto structural test cases for GP have been regenerated with the new model.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <u>3/6/95</u>		

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1. Configuration Item: Verification Cases - Driver	2. Date: 3/7/95	3. Formal Modification #: 22
4. Part of Configuration Item Affected: The driver for the structural test cases for Mercury		
5. Reason for Modification: The driver file needs to be modified to use the correct test cases.		
6. Modification: The driver was modified to build the correct test case names.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 3/7/95		

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1. Configuration Item: Verification Cases - Structural Test cases for TDLRSP for Mercury	2. Date: 3/10/95	3. Formal Modification #: 23
4. Part of Configuration Item Affected: The structural test cases, expected values and Mathematica driver files for Mercury		
5. Reason for Modification: The test cases and expected values files had errors from Mathematica because no initial conditions were input, so Mathematica did not know what to do with them.		
6. Modification: The Mathematica drivers were corrected by adding a call to the input file and replaced. The Test cases and expected values were re created.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst		

3/10/95

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1. Configuration Item: Verification Cases - Models and test cases.	2. Date: 3-14-95	3. Formal Modification #: 24
4. Part of Configuration Item Affected: ASP.M, ASP_NR_XXX.TC & EX, and ASP_RO_XXX.TC & EX, GP.M, GP_NR_XXX.TC & EX, and GP_RO_XXX.TC & EX SP.M, SP_001.TC & EX, GPSF_001-008.TC & EX, FRAME.M, FRAME_001-009.TC & EX		
5. Reason for Modification: Models must be updated to reflect new Spec Mod.2.3-7.		
6. Modification: 1) The ASP.M model has been updated to calculate the mean and standard deviation only if all status are healthy and previous accelerations are not identical. The test input and expected values files (ASP_NR_XXX.TC & EX and ASP_RO_XXX.TC & EX) have been regenerated. 2) The GP.M model has been updated to include the MAX function on the RHS of the MAX_NORMAL_VELOCITY comparison in table 5.9 and 5.10. The test input and expected values files (GP_NR_XXX.TC & EX and GP_RO_XXX.TC & EX) have been regenerated. 3) The SP.M model has been replaced by SP_001.M. The new file contains the test data as well as the calls to the functional unit models without directory references for the calls. The test input and expected values files (SP_001.TC & EX and SP_001.TC & EX) have been regenerated because the ASP.M model has been changed. 4) The test input and expected values files (GPSF_XXX.TC & EX and GPSF_XXX.TC & EX) have been regenerated because the GP.M model has been changed. 5) The FRAME.M model has been updated by removing directory references from calls to individual functional unit models. The test input and expected values files (FRAME_XXX.TC & EX and FRAME_XXX.TC & EX) have been regenerated because the ASP.M and GP.M models have been changed.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 3/23/95		

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1. Configuration Item: Structural Test Cases for ASP and GP VERIFICATION CASES	2. Date: 3/14/95	3. Formal Modification #:25
4. Part of Configuration Item Affected: Structural Test Cases for ASP and GP - for MERCURY		
5. Reason for Modification: Structural test cases and the expected results have to be regenerated using the new <i>Mathematica</i> model due to Spec Mod 2.3.7. -model was changed in SDCR #24		
6. Modification: The <i>Mathematica</i> code for ASP and GP was corrected in accordance to Spec. Mod 2.3.7 and the structural test cases were recreated.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 4/3/95		

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1. Configuration Item: Verification Cases - Structural test cases for Pluto.	2. Date: 3-14-95	3. Formal Modification #: 26
4. Part of Configuration Item Affected: ASP_PST_XXX.TC & EX, GP_PST_XXX.TC & EX		
5. Reason for Modification: Structural test case inputs and expected results must be regenerated with the new model. <i>Model changed under SDR #24</i>		
6. Modification: Input and expected-values files have been regenerated for Pluto's GP and ASP functional units. <i>(structural test cases)</i>		
7. SQA Signature & Date: Original Signed by <u>Kelly Hayhurst</u> <u>4/5/95</u>		

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1. Configuration Item: RECLP test case # 68 <i>Verification CASES - Mercury *</i>	2. Date: 3/14/95	3. Formal Modification #:27
4. Part of Configuration Item Affected: RECLP_NR_068.TC and RECLP_NR_068.EX		
5. Reason for Modification: An error was detected in the value to THETA while doing MC/DC testing. THETA had the wrong initial value so that the expected value was calculated wrong.		
6. Modification: The correct initial value of Theta was put into test case 68 <i>*The error in these test cases was discovered ^{discovered} while developing structural test cases for Mercury</i>		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <div style="text-align: right;"><u>3/14/95</u></div>		

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1. Configuration Item: Verification Cases - model for TDLRSP .	2. Date: 3-30-95	3. Formal Modification #: 28
4. Part of Configuration Item Affected: TDLRSP.M, TDLRSP_NR_XXX.TC & EX, TDLRSP_RO_XXX.TC & EX, SP_001.TC & EX, FRAME_XXX.TC & EX		
5. Reason for Modification: The TDLRSP model needs to be corrected to properly assign the value of K_MATRIX for cases not specified in table 5.11 and where no beams are in lock. All TDLRSP requirements based test cases need to be regenerated based on the new TDLRSP model. The SP and all FRAME test cases need to be regenerated based on the new TDLRSP model.		
6. Modification: The TDLRSP model now assigns K_MATRIX values properly. Debug print statements have been added to help future debugging efforts. The TDLRSP requirements based test cases have been regenerated. The SP test case has been regenerated. The FRAME test cases have been regenerated. No changes were actually made to TDLRSP model with respect to K-MATRIX (the values in the original model were correctly assigned). The only modification was the addition of debugging statements <i>Kgt 4/5/95</i>		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <u>4/5/95</u>		

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1. Configuration Item: MERCURY Structural Test Cases for TDLRSP <i>VERIFICATION CASES</i>	2. Date: 4/3/95	3. Formal Modification # 29
4. Part of Configuration Item Affected: MERCURY Structural Test Cases for TDLRSP.		
5. Reason for Modification: Structural test cases and the expected results have to be regenerated using the new <i>Mathematica</i> model (SDCR 28) due to an error discovered in the TDLRSP <i>Mathematica</i> code by the MERCURY tester.		
6. Modification: MERCURY Structural test cases for TDLRSP were recreated using the <i>Mathematica</i> code corrected in SCDR 28.		
7. SQA Signature & Date: Original Signed by <i>Kelly Hayhurst</i> <u>4/6/95</u>		

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1. Configuration Item: Verification Cases	2. Date: 4-2-95	3. Formal Modification #: 30																					
4. Part of Configuration Item Affected: TDLRSP_PST_XXX.TC & EX																							
5. Reason for Modification: The expected results files need to be regenerated based on the new TDLRSP.M model.																							
6. Modification: Pluto structural test cases for TDLRSP are no longer needed. Test cases from the TDLRSP requirements based suite have been found to provide the same test coverage. The following replacements have been made: <table><tr><td>TDLRSP_PST_001.TC & EX</td><td>replaced by</td><td>TDLRSP_RO_006.TC & EX</td></tr><tr><td>TDLRSP_PST_002.TC & EX</td><td>replaced by</td><td>TDLRSP_RO_026.TC & EX</td></tr><tr><td>TDLRSP_PST_003.TC & EX</td><td>replaced by</td><td>TDLRSP_RO_002.TC & EX</td></tr><tr><td>TDLRSP_PST_004.TC & EX</td><td>replaced by</td><td>TDLRSP_RO_026.TC & EX</td></tr><tr><td>TDLRSP_PST_005.TC & EX</td><td>replaced by</td><td>TDLRSP_NR_021.TC & EX</td></tr><tr><td>TDLRSP_PST_006.TC & EX</td><td>replaced by</td><td>TDLRSP_NR_004.TC & EX</td></tr><tr><td>TDLRSP_PST_007.TC & EX</td><td>replaced by</td><td>TDLRSP_NR_003.TC & EX</td></tr></table>			TDLRSP_PST_001.TC & EX	replaced by	TDLRSP_RO_006.TC & EX	TDLRSP_PST_002.TC & EX	replaced by	TDLRSP_RO_026.TC & EX	TDLRSP_PST_003.TC & EX	replaced by	TDLRSP_RO_002.TC & EX	TDLRSP_PST_004.TC & EX	replaced by	TDLRSP_RO_026.TC & EX	TDLRSP_PST_005.TC & EX	replaced by	TDLRSP_NR_021.TC & EX	TDLRSP_PST_006.TC & EX	replaced by	TDLRSP_NR_004.TC & EX	TDLRSP_PST_007.TC & EX	replaced by	TDLRSP_NR_003.TC & EX
TDLRSP_PST_001.TC & EX	replaced by	TDLRSP_RO_006.TC & EX																					
TDLRSP_PST_002.TC & EX	replaced by	TDLRSP_RO_026.TC & EX																					
TDLRSP_PST_003.TC & EX	replaced by	TDLRSP_RO_002.TC & EX																					
TDLRSP_PST_004.TC & EX	replaced by	TDLRSP_RO_026.TC & EX																					
TDLRSP_PST_005.TC & EX	replaced by	TDLRSP_NR_021.TC & EX																					
TDLRSP_PST_006.TC & EX	replaced by	TDLRSP_NR_004.TC & EX																					
TDLRSP_PST_007.TC & EX	replaced by	TDLRSP_NR_003.TC & EX																					
7. SQA Signature & Date: Original Signed by Kelly Hayhurst																							

4/5/95

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1. Configuration Item: Verification Cases - Trajectory Group	2. Date: 4-2-95	3. Formal Modification #: 31
4. Part of Configuration Item Affected: RUN_TRAJ.COM - support file to run simulator test cases.		
5. Reason for Modification: The directory specific references should be removed from the RUN_TRAJ.COM file so that the user will not need to correct the directory reference before running trajectory test cases.		
6. Modification: The absolute directory reference has been replaced with a relative reference.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst		
4/3/95		

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1. Configuration Item: Verification Cases	2. Date: 4-7-95	3. Formal Modification #: 32
4. Part of Configuration Item Affected: P_LNK*.COM -- files for linking test support files		
5. Reason for Modification: The files listed below have the "/DEBUG" option in the link statement and is very inconvenient to use. The "/DEBUG" option should be removed because it is unnecessary. P_LNKRECLP.COM P_LNKCRCRCP.COM P_LNKCPC.COM		
6. Modification: The "/DEBUG" options have been removed from the files		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst		

4/7/95

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1. Configuration Item: Verification Cases	2. Date: 4-7-95	3. Formal Modification #: 33
4. Part of Configuration Item Affected: P_*_DRIVER.COM -- files for subframe test cases		
5. Reason for Modification: The files listed below have Mercury directory references and should be corrected to run pluto files P_GPSF_DRIVER.COM P_CLP_DRIVER.COM		
6. Modification: The Mercury references have been replaced by Pluto directory references.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 4/7/95		

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1. Configuration Item: Verification Cases -- Mercury Structural test cases	2. Date: 4-10-95	3. Formal Modification #: 34
4. Part of Configuration Item Affected: m_asp_st_004-006.tc, ex		
5. Reason for Modification: Wrong model used in generating test cases.		
6. Modification: Used correct model from CMS to recreate these test cases.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst		

4/10/95

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1. Configuration Item: Verification Cases	2. Date: 4-7-95	3. Formal Modification #: 35
4. Part of Configuration Item Affected: M_RUN_TRAJ.COM		
5. Reason for Modification: Due to a change in directory structure the M_RUN_TRAJ.COM file must be corrected to reflect this change.		
6. Modification: The directory structure was changed from [DBT.TEST_CASES.TRAJ] to [DBT.TRAJ] in M_RUN_TRAJ.COM..		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <u>4/10/95</u>		

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1. Configuration Item: Verification Cases	2. Date: 4-10-95	3. Formal Modification #: 36
4. Part of Configuration Item Affected: AP_PST_002.TC * EX		
5. Reason for Modification: This test case has to be updated to account for the new structure of ASP after PR-27 modifications. Since the structure of ASP has changed, the path to reach the decision being tested by the test case is slightly different.		
6. Modification: The A_ACCELERATION variable for X axis has been changed so that its 3 history values are different and require the standard deviation computation. This leads to the check for extreme values.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <u>4/10/95</u>		

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1. Configuration Item: Verification Cases	2. Date: 4-10-95	3. Formal Modification #: 37						
4. Part of Configuration Item Affected: GP_NR_053.EX1, TDLRSP_NR_006.TC & EX TDLRSP_PST_*.TC * EX								
5. Reason for Modification: The following is a list of files in CMS no longer used in the testing procedure for the given reasons: <table border="0"><tr><td>GP_NR_053.EX1</td><td>This file has never been part of the GP suite</td></tr><tr><td>TDLRSP_NR_006.TC & EX</td><td>This test case has been renamed TDLRSP_RO_006.TC & EX</td></tr><tr><td>TDLRSP_PST_*.TC & EX</td><td>During a review TDLRSP test cases for SDCR-28 & SDCR 30, it is discovered that there are requirements based test cases that provide the same coverage. These structural test cases are no longer needed.</td></tr></table>			GP_NR_053.EX1	This file has never been part of the GP suite	TDLRSP_NR_006.TC & EX	This test case has been renamed TDLRSP_RO_006.TC & EX	TDLRSP_PST_*.TC & EX	During a review TDLRSP test cases for SDCR-28 & SDCR 30, it is discovered that there are requirements based test cases that provide the same coverage. These structural test cases are no longer needed.
GP_NR_053.EX1	This file has never been part of the GP suite							
TDLRSP_NR_006.TC & EX	This test case has been renamed TDLRSP_RO_006.TC & EX							
TDLRSP_PST_*.TC & EX	During a review TDLRSP test cases for SDCR-28 & SDCR 30, it is discovered that there are requirements based test cases that provide the same coverage. These structural test cases are no longer needed.							
6. Modification: Files should be removed from CMS								
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <u>4/10/95</u>								

Support Documentation Change Report

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1. Configuration Item:
Verification Cases

2. Date:
4-14-95

3. Formal Modification #:
38

4. Part of Configuration Item Affected:
P_RUN_TRAJ.COM

5. Reason for Modification:

The call to TRAJ.COM in this file must be changed to P_TRAJ to accomodate for the name change of TRAJ.COM to P_TRAJ.COM.

6. Modification:

Calls to TRAJ.COM changed to P_TRAJ.COM

7. SQA Signature & Date:

Original Signed by
Kelly Hayhurst

4/14/95

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1. Configuration Item: Verification Cases and Procedures Document	2. Date: 12-8-94	3. Formal Modification #: 8 1
4. Part of Configuration Item Affected: Test procedures must be modified to be more specific. Details of the required test case directory structure must be added. Description of test case execution tracking needs to be added.		
5. Reason for Modification: DO-178B requires specific test case execution procedures. The tracking of test case execution needs to be added.		
6. Modification: A step by step test execution procedure has been added. Appendix D and E has been combined and the appendixes that follow have been renumbered. An example of a test log has been added as Appendix F. Titles have been added to the appendixes. The original Test Procedure section has been renamed to Test Case Development Procedure.		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst 12/15/94		

SIM.CODE

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1. Configuration Item: Simulator source code	2. Date: 3-28-95	3. Formal Modification #: 1
4. Part of Configuration Item Affected: TRAJ_SIM.EXE		
5. Reason for Modification: Trajectory simulator prints out incorrect accuracy data in the ACC_LIM_OUTPUT.DAT file.		
6. Modification: Corrected the bug which was producing incorrect data in the file: ACC_LIM_OUTPUT.DAT when the following occurs <ul style="list-style-type: none">1) multiple implementations are executed2) the accuracy check is performed on an integer or logical3) and the value of the driving implementation's variable is zero		
7. SQA Signature & Date: Original Signed by Kelly Hayhurst <u>4/3/95</u>		

REPORT DOCUMENTATION PAGE					Form Approved OMB No. 0704-0188	
<p>The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.</p> <p>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</p>						
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14. ABSTRACT <p>The Guidance and Control Software (GCS) project was the last in a series of software reliability studies conducted at Langley Research Center between 1977 and 1994. The technical results of the GCS project were recorded after the experiment was completed. Some of the support documentation produced as part of the experiment, however, is serving an unexpected role far beyond its original project context. Some of the software used as part of the GCS project was developed to conform to the RTCA/DO-178B software standard, "Software Considerations in Airborne Systems and Equipment Certification," used in the civil aviation industry. That standard requires extensive documentation throughout the software development life cycle, including plans, software requirements, design and source code, verification cases and results, and configuration management and quality control data. The project documentation that includes this information is open for public scrutiny without the legal or safety implications associated with comparable data from an avionics manufacturer. This public availability has afforded an opportunity to use the GCS project documents for DO-178B training. This report provides a brief overview of the GCS project, describes the 4-volume set of documents and the role they are playing in training, and includes configuration management and quality assurance documents from the GCS project.</p>						
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